Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

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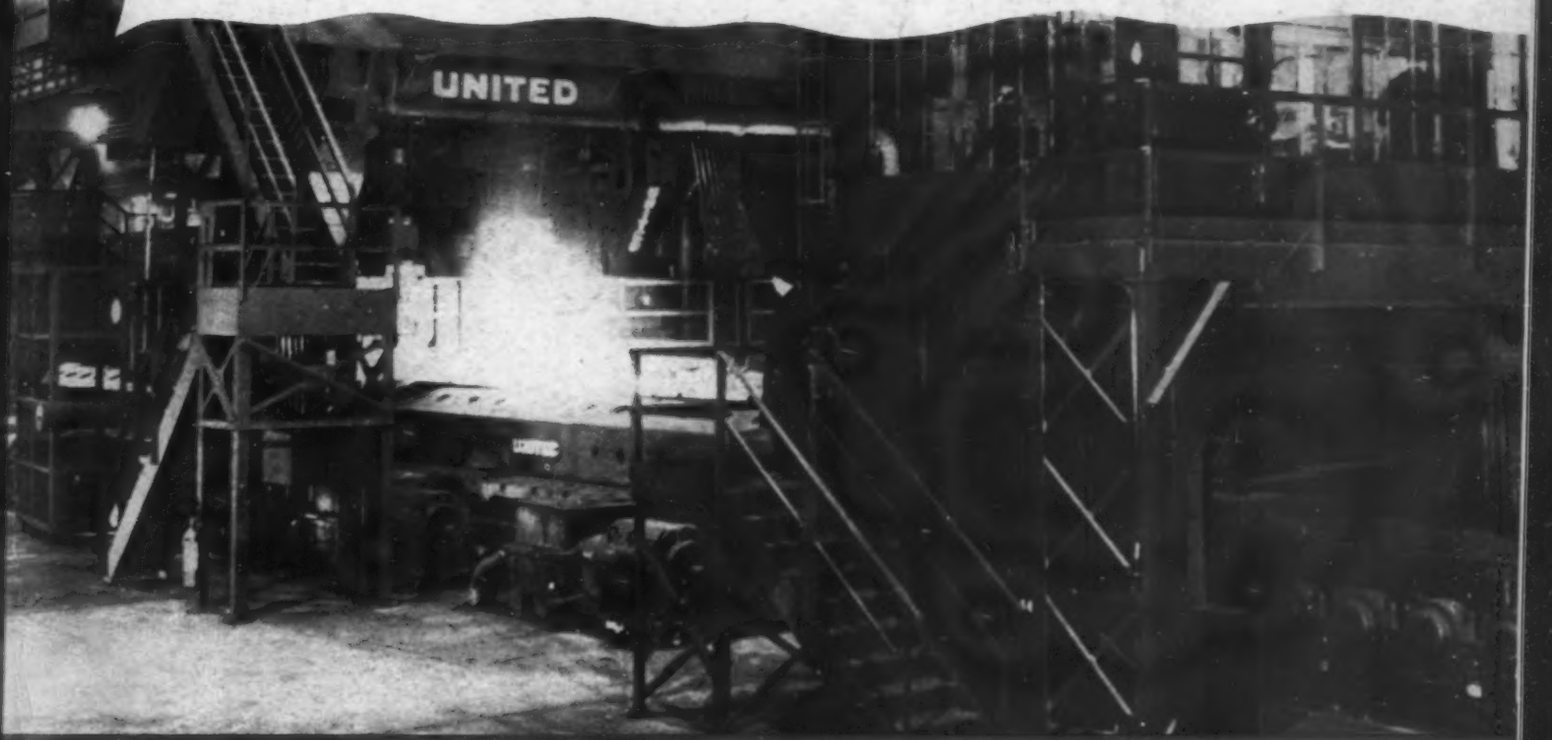
SEPTEMBER, 1947

OCT 14 1947
DETROIT

TECHNOLOGY DEPARTMENT

159,792 tons in a month!



Another World Record

BY A TIMKEN BEARING EQUIPPED SLABBING MILL

When this mill went into operation at the Homestead Works of Carnegie-Illinois Steel Corporation (Pittsburgh district) more than two years ago, it was the first mill of its type to be equipped with anti-friction bearings; it still is the only slabbing mill so equipped.

Since the day the mill began to turn out slabs on a production basis, its performance has been phenomenal. Earlier this year it rolled 588 ingots totalling 9,706 net ingot tons in 24 hours — one ingot every 2.4 minutes, a record never even approached by any other slabbing mill!

Now it has set another and still more remarkable record by rolling 159,792 ingot tons in a single month. This exceeds the previous monthly production record by more than 8,000 tons.

For tops in rolling mill production, get the tops in rolling mill bearings — Timken Balanced Proportion Roll Neck Bearings. For specific information consult your mill builder or our engineers.

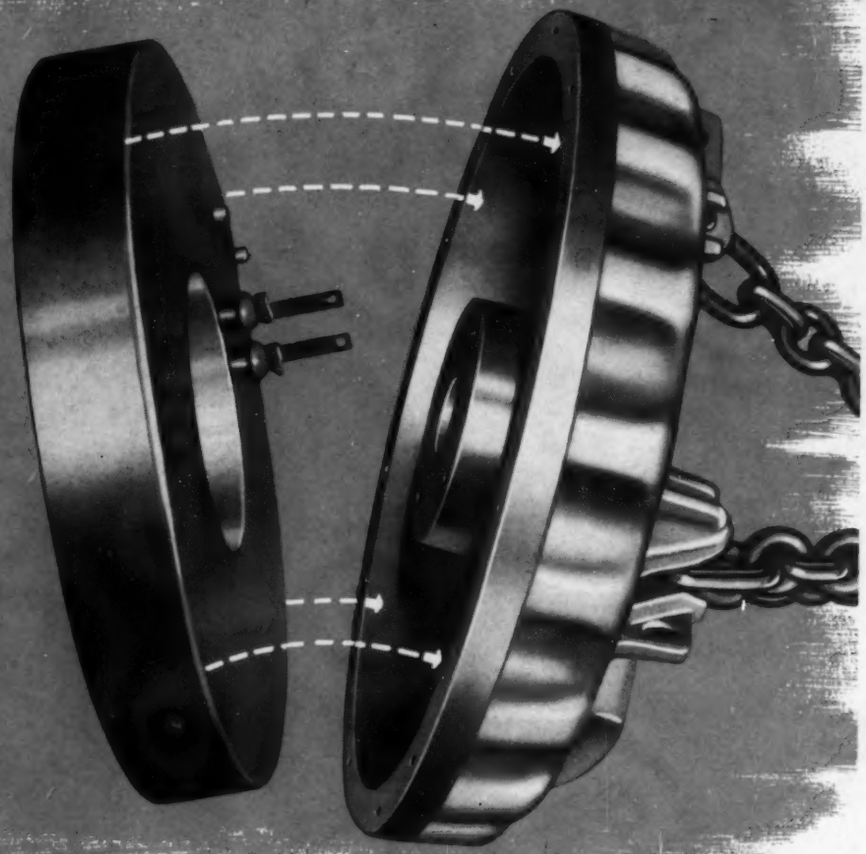
TIMKEN
ROLL NECK BEARINGS

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

TIMKEN TAPERED ROLLER BEARINGS TAKE RADIAL AND THRUST LOADS OR ANY COMBINATION

Now! **New CAPSULE-COIL Magnet Construction**

FOR LONGER LIFE AND EASY ON-THE-JOB COIL REPLACEMENT

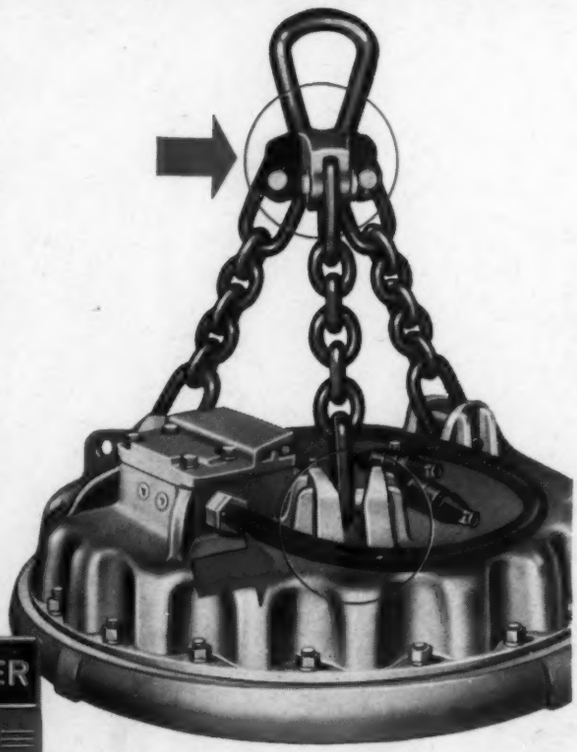


Now! **New anti-wear features prolong chain life**

Cutler-Hammer Supermagnets now embody a new welded, steel-sheathed CAPSULE-COIL sealed against moisture. With this new design plus removable pole shoes *YOU CAN REPLACE A COIL* easily, quickly and with a minimum of "time-out". For coil repairs, only the CAPSULE-COIL need be returned to the manufacturer. With a spare CAPSULE-COIL replacement, your Supermagnet goes back to work at once.

Also NEW, a radically different chain suspension, replacing the conventional top link with a new "non-twist", anti-wear yoke. This, plus redesigned, streamlined body lugs, materially eliminates trouble at the spots where chain usually wears out.

These major Cutler-Hammer advances match other Supermagnet features . . . high permeability steel spool, part of magnetic path . . . strap copper windings insulated by impregnated asbestos ribbon . . . high dielectric, bonded, mica discs between coil layers and CAPSULE case . . . tung oil impregnation . . . pressurized baking process. These superiorities—the result of 50 years of engineering leadership—merit your selection of "Cutler-Hammer" for your next magnet requirement . . . CUTLER-HAMMER, Inc., 1257 St. Paul Ave., Milwaukee 1, Wisconsin.



CUTLER-HAMMER
SUPERMAGNETS
C-H

IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress March 3, 1879. $7.50 per year in United States, $8.25 Canada, $10.00 foreign countries. Volume 24, No. 8.

NEW 10-STAND FORMING & WELDING MILL FOR CONTINUOUS BUTTWELD PIPE

more and better pipe at less cost—

Out with the old . . . in with the new.

Aetna-Standard announces another improvement in the manufacture of pipe in the continuous butt weld process. A new 10-stand forming and welding mill in place of the conventional 6-stand mill.

The 10-stand mill produces three distinct production and cost advantages:

1. **Much greater output.** Production will be as much as 50% greater on some sizes of pipe than with mills now in use. The reason—use of wider skelp, greater reduction and elongation.
2. **Higher furnace efficiency.** Use of wider skelp for the small sizes of pipe utilizes furnace capacity to better advantage. Speed through furnace need not be increased to increase production.
3. **Better quality.** It has been proven that the more work done in reducing increases quality of weld.

As in all fields, industry looks to the leader for new ideas and new developments. In continuous butt weld pipe and seamless tube, Aetna-Standard has built more mills than all other companies combined.

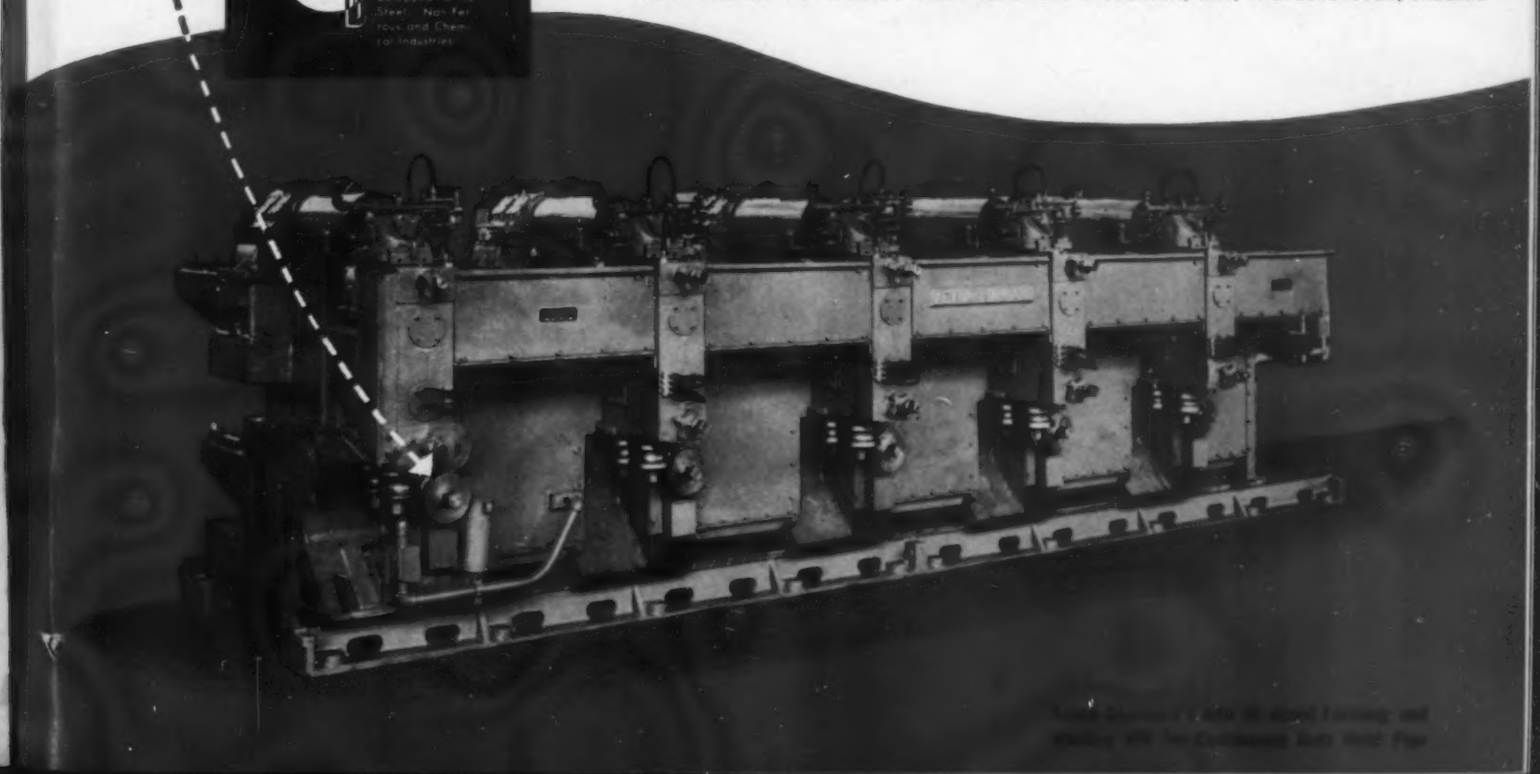
The first installation of the new Aetna-Standard 10-stand continuous butt weld pipe mill is nearing completion. If you want more information on design, production, costs or other phases of this type of pipe mill, let us hear from you.

THE MAINTENANCE CREW CAN CHEER, TOO

1. Better guards to shield mill and adjacent parts from scale and water.
2. More accessible and improved roll adjustments.
3. All rotating shafts mounted in oil-tight casings.
4. All gears enclosed in oil-tight casings.
5. Roll spindle bearings lubricated from centralized grease system.
6. Drives lubricated from centralized oil system.
7. Individual motor drives (more flexibility in setting ratio of reduction, and longer roll life.)

THE AETNA-STANDARD ENGINEERING COMPANY
YOUNGSTOWN, OHIO

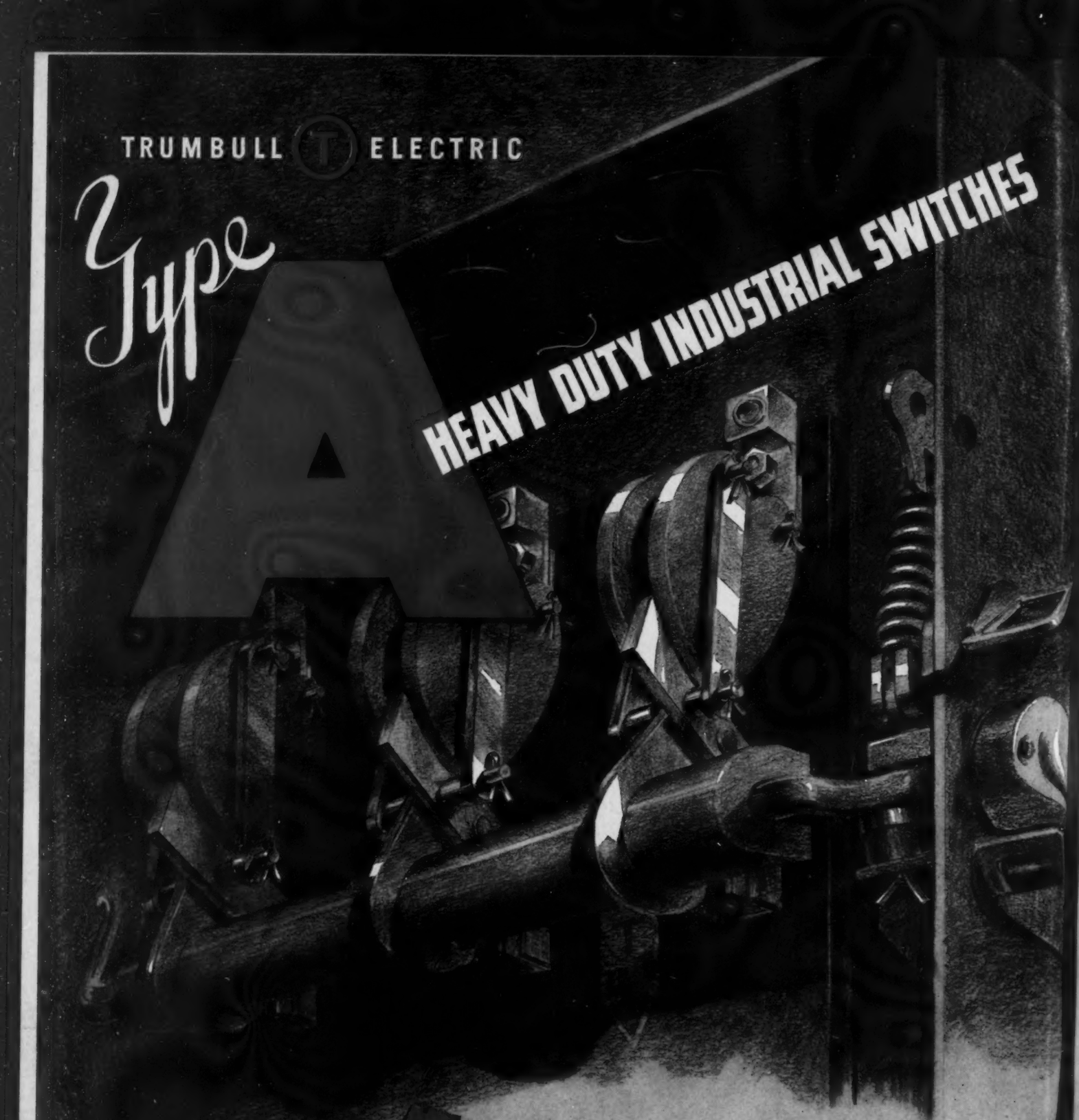
ASSOCIATED COMPANY: HEAD WRIGHTSON & COMPANY, LTD., MIDDLESBROUGH, ENGLAND



TRUMBULL ELECTRIC

Type A

HEAVY DUTY INDUSTRIAL SWITCHES



BLADE TIE-IN CROSS-BAR
Total disconnect, permanent blade alignment.

PADLOCKS THREE WAYS
Locks "on" — locks "off" — locks closed cover.

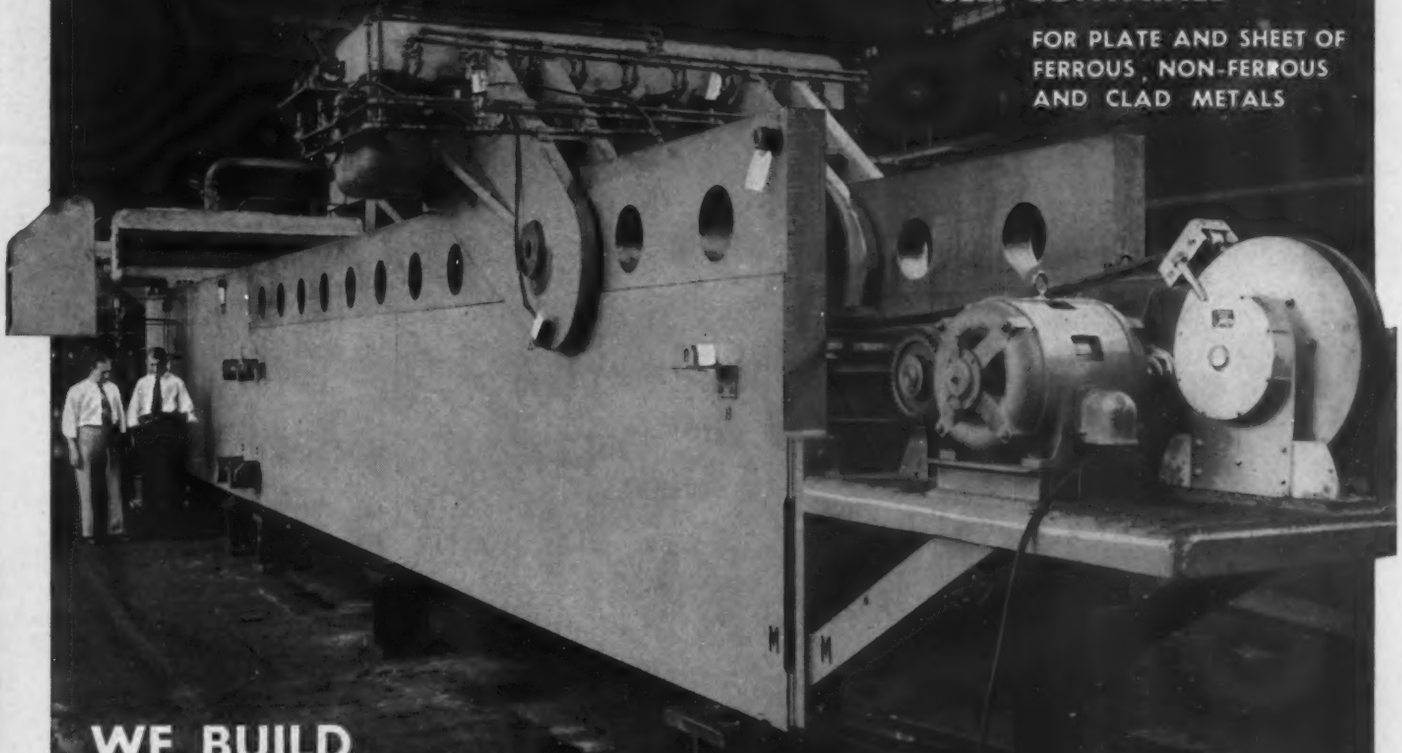
BUILT FOR INDUSTRY'S TOUGHEST JOBS
Machined parts, silvered contacts, snuf-arcs.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY
PLAINVILLE, CONNECTICUT
OTHER FACTORIES AT NORWOOD, OHIO • SAN FRANCISCO • SEATTLE • NORTH HOLLYWOOD

The Largest Hydraulic Plate Stretcher-Leveller ever built

825 TON CAPACITY
SELF-CONTAINED

FOR PLATE AND SHEET OF FERROUS, NON-FERROUS AND CLAD METALS



WE BUILD

ALL TYPES OF STRETCHING- LEVELLING EQUIPMENT

HYDRAULICALLY OPERATED OR ROLLER TYPE

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ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS · PUMPS
ACCUMULATORS · DIE CASTING MACHINES

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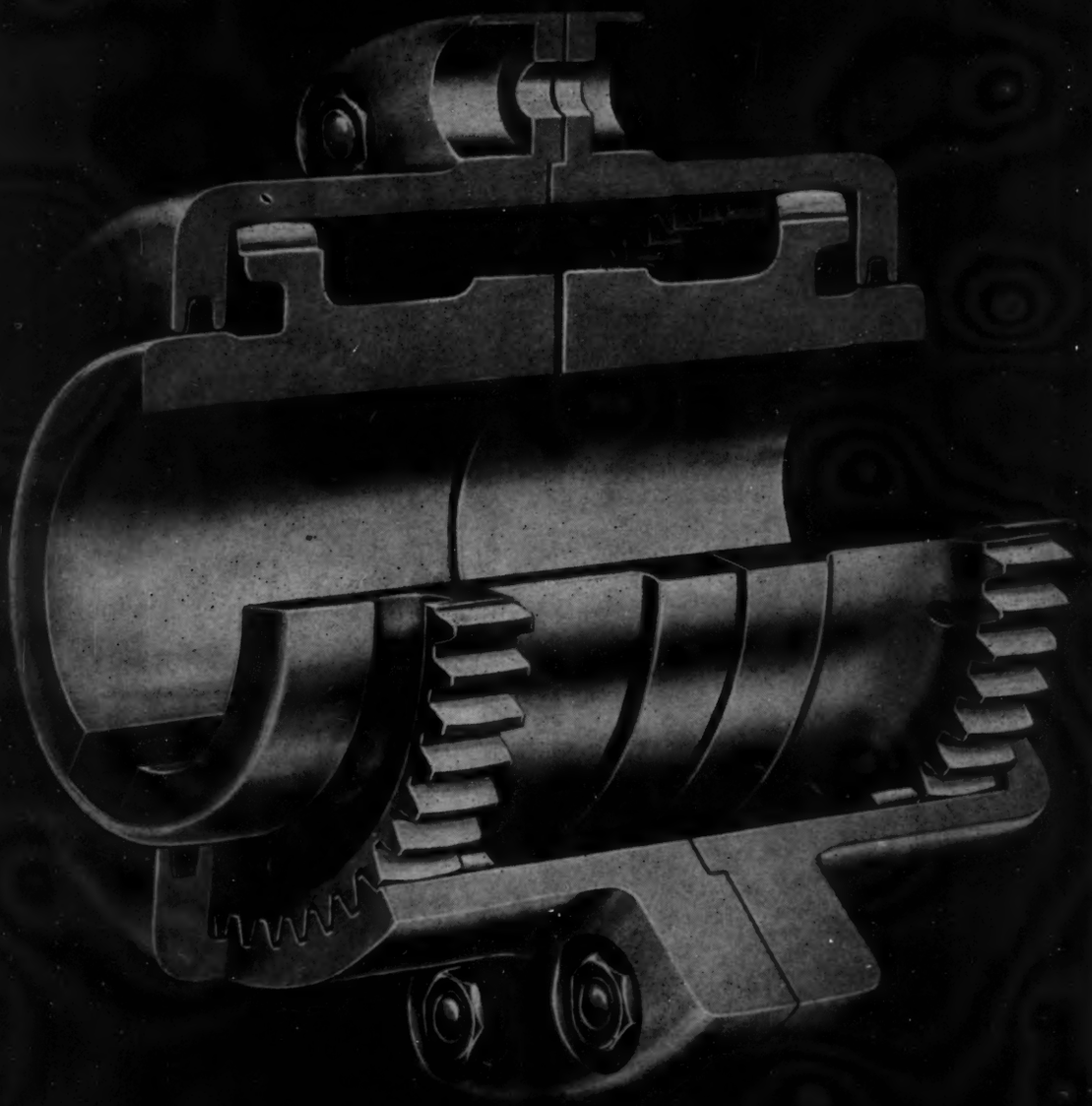
DETROIT SAN FRANCISCO SEATTLE WASHINGTON, D. C.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

The First Morgan
Continuous Rolling Mill

Greater Production of Better Products

WITH

MORGAN WORCESTER

ROLLING MILL EQUIPMENT

Modern Morgan Rolling Mills have been specifically developed by skilled technical pioneers to meet the demands of mass production. Their contributions, as partially listed at the left, have given industry the rolling mill equipment it needs to produce . . . more products . . . better products . . . at less cost.

Made with skill, Morgan equipment produces larger tonnages easier, with greater safety. Bring your problem to Morgan.

A few Morgan Rolling Mill Contributions Developed and Patented since 1892

- Continuous Billet and Sheet Bar Mill
- Continuous Skelp Mill
- Continuous Mill—Twist Guides
- Automatic Rod Reel
- Continuous Billet Heating Furnace
- Hydraulic Flying Shear
- Steam Flying Shear
- Up and Down Cut Flying Shear
- Duo-Finishing Mill
- Escapement Type Cooling Bed
- Universal Type Cooling Bed
- Carry-over Type Cooling Bed
- Automatic Pack Annealing on Cooling Bed
- Four Strand Rod Mill
- Double Strand Merchant Mill
- Skew Y Reversing Tables
- Edging Mills
- Vertical Mills
- Morgoil Bearings

MORGAN CONSTRUCTION COMPANY

WORCESTER, MASSACHUSETTS RM-8

Rolling Mills — Wire Mills

Gas Producer Machines — Regenerative Furnace Control

English Representative:
International Construction Co., 56 Kingsway, London, W. C. 2, England

A Modern Morgan Mill

THE WORLD'S LARGEST BUILDER OF THE WORLD'S LARGEST CRANES

Unsurpassed LIFTING POWER- *Alliance*

Alliance builds many types of cranes to help you move heavy loads of raw materials, hot metals, slabs, ingots, semi-finished and finished products . . . safely, quickly, and easily. Developed by the world's largest builder of the world's largest cranes, Alliance equipment is designed for long, rugged service . . . gives you unsurpassed, economical lifting power wherever it's needed in your plant.

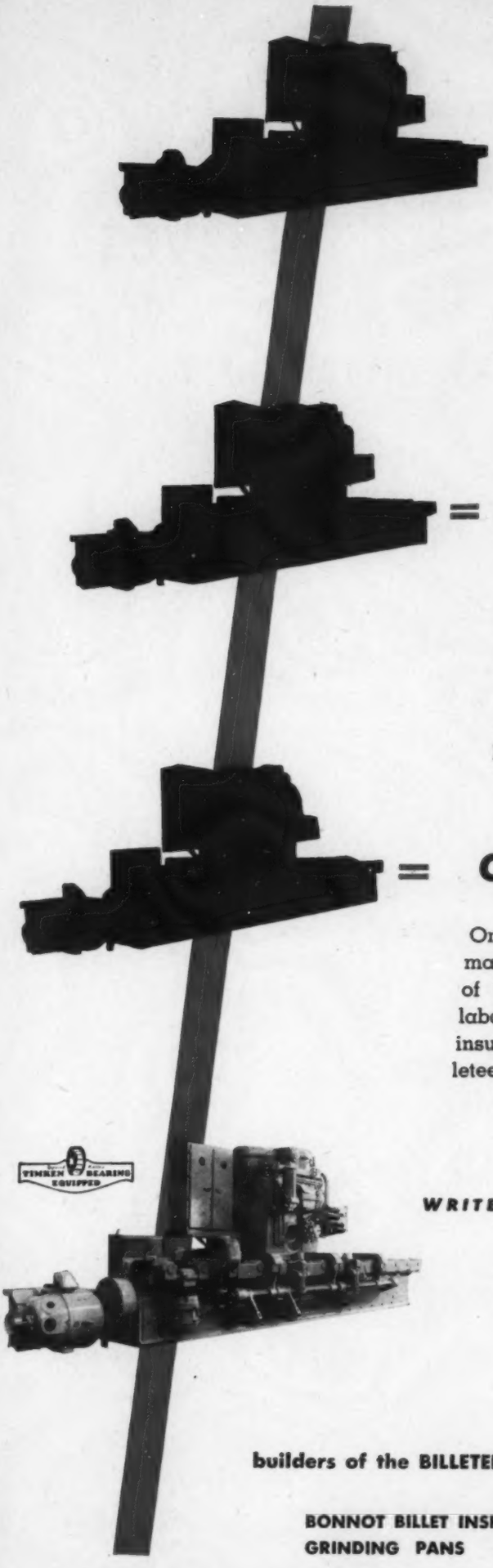
Whatever your handling problem, whatever the loads involved, it always pays to check with Alliance. Let our fifty years of experience in development and manufacture of cranes assist you in giving your plant dependable, *extra* lifting power.

LADLE CRANES • GANTRY CRANES
SOAKING PIT CRANES • STRIPPER CRANES
FORGING MANIPULATORS
SLAB AND BILLET CHARGING MACHINES
OPEN HEARTH CHARGING MACHINES
SPECIAL MILL MACHINERY
STRUCTURAL FABRICATION

THE ALLIANCE MACHINE CO.

Main Office
ALLIANCE, OHIO

Pittsburgh Office
1022 OLIVER BLDG., PITTSBURGH, PA.



= 100% Scrap Recovery

The Billeteer saves every ounce of steel removed from billets . . . classified according to analysis . . . ready for the charging box. One mill, operating four Billeteers, saves over six tons of scrap a day . . . more than 2000 tons a year. And all this over and above the fact that the Billeteer permits salvage of billets so badly scarred that hand-chipping or flame conditioning would be impractical.

= Greater Speed

One Billeteer does the work of 10 manual chippers, and does it better. Operation of the Billeteer is simple . . . operator can be quickly trained. Designed and built for long, trouble-free service, the Billeteer keeps thoroughly cleaned billets moving rapidly and steadily from the billet shed . . . sets a more profitable pace throughout your plant.

= Greater Economy

One plant using Billeteers saved $892,528 (over manual-chipping) in conditioning 714,022 net tons of billets. By increasing billet output, cutting labor costs, increasing worker efficiency, and insuring steady, dependable operation, the Billeteer can effect impressive savings in your plant.

TIMKEN BEARING EQUIPPED

WRITE TODAY FOR FULL INFORMATION

Engineered

FOR LOWER OPERATING COSTS

BONNOT

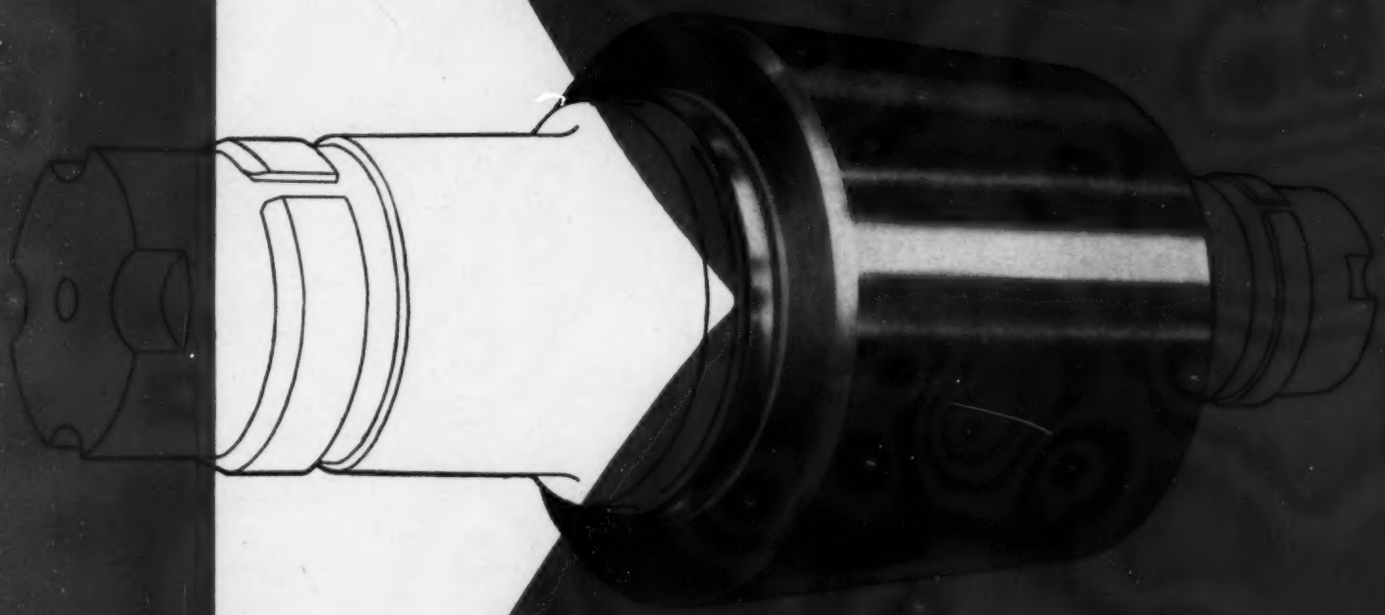
builders of the BILLETEER • THE BONNOT COMPANY • CANTON 2, OHIO

BONNOT BILLET INSPECTION TABLES • CHARGING TABLES • COLD SAWS
GRINDING PANS • CLAY MIXERS • CLAY FEEDERS, ETC.

3 Main Reasons Why—

Heppenstall Sleeves

cut back-up roll costs



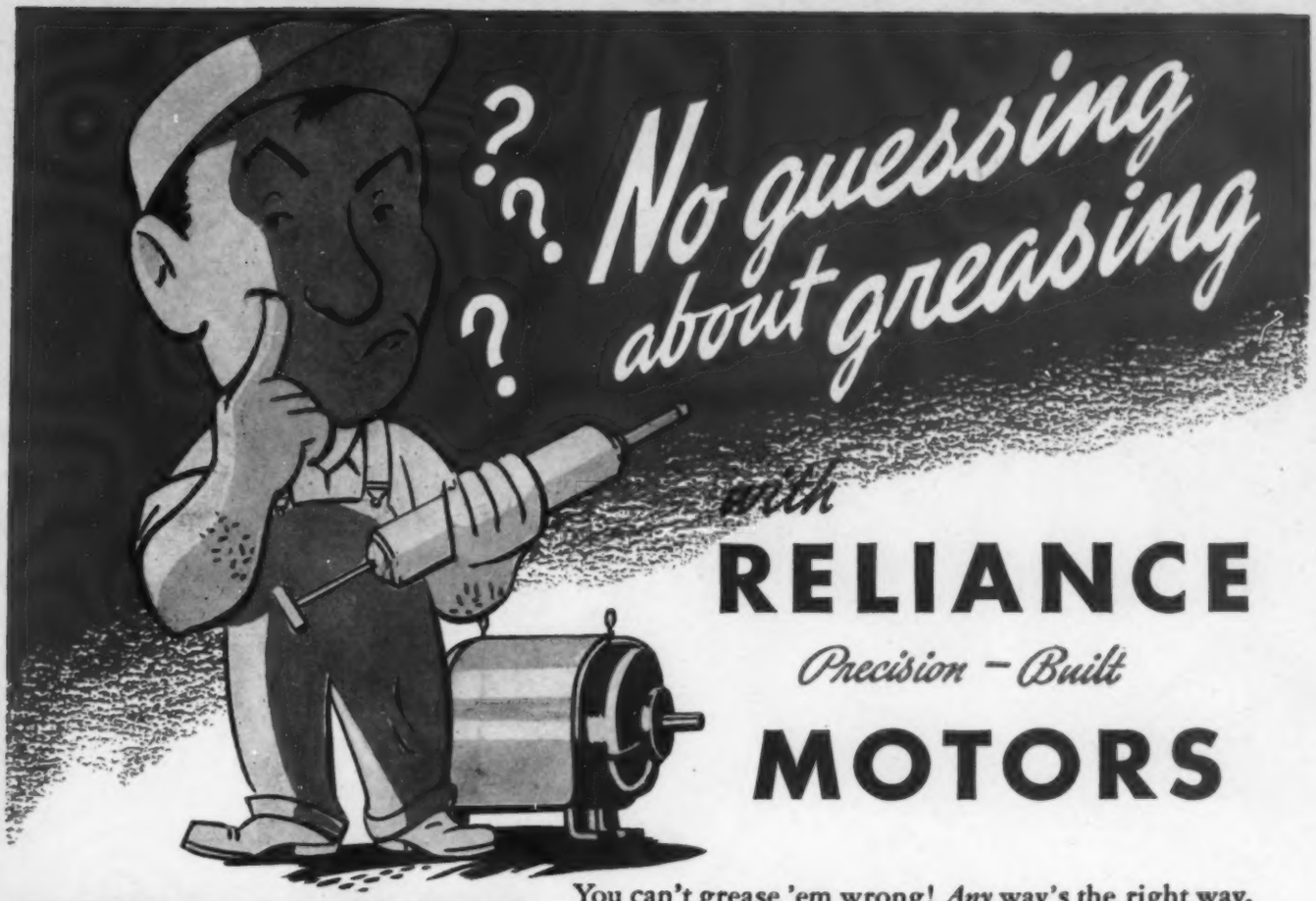
1. *First Cost is Lower*—Heppenstall forged-steel sleeves cost less than solid rolls and are furnished from alloy steel of our own manufacture.

2. *They Last Longer*—Heppenstall sleeves provide working surfaces which outlast solid rolls because they are "tailor-made" and heat treated to the hardness required for any specific application.

3. *They Save Worn Rolls*—Why scrap a worn back-up roll when it can be re-sleeved several times? Heppenstall has every facility for correctly sizing your solid rolls to form arbors . . . and for perfect shrink-fitting of sleeves to arbors.

If you are interested in greater tonnage at lower cost, investigate the advantages of Heppenstall sleeves. And remember, too, that Heppenstall produces forged arbors—also "tailor-made" as to both material and strength for extra service. Write Heppenstall Company, Pittsburgh 1, Pa.

the most dependable name in forgings— **Heppenstall**



No guessing about greasing

with

RELIANCE

Precision-Built

MOTORS

This special bearing design protects Reliance Precision-Built Motors indefinitely!

You can't grease 'em wrong! *Any* way's the right way. That's because Reliance *Precision-Built* Motors are designed to eliminate lubrication worries. On the majority of applications these factory-lubricated motors perform dependably *for years* without additional lubrication. In cases where conditions make occasional attention necessary—or if it is your practice to lubricate at regular intervals—overgreasing or undergreasing make no difference. Send for Bulletin C-118 which tells how Reliance *Precision-Built* Motors end your lubrication worries!

RELIANCE ELECTRIC & ENGINEERING CO.

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Dallas • Denver • Detroit • Gary • Grand Rapids • Greenville, S. C.
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New Orleans • New York • Philadelphia • Pittsburgh • Portland, Ore.
Roanoke, Va. • Rockford • St. Louis • San Francisco • Seattle • Syracuse
Tampa • Tulsa • Washington, D. C. • Sao Paulo, Brazil

RELIANCE A-C D-C MOTORS

"Motor-Drive is More Than Power"

"THEY BEEN WORKIN' FOR THE MILL LONGER'N I HAVE!"

NOT THE SAME ROLLS, but the same make—LEWIS.

Many an old-time Roll Boss "inherited" Lewis Rolls from *his* boss and has never had reason to change the brand. That's because, year after year, they consistently help to maintain peak production at the lowest cost per ton rolled.

LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX COMPANY
PITTSBURGH, PA.

PLAIN CHILLED IRON ROLLS

MOLYBDENUM CHILLED IRON ROLLS

LEWIS "X" AND LEWIS "XA"

LEWIS SUPERIOR "X" ROLLS
(Nickel Grain Type)

ATLAS and ATLAS "B" ROLLS
(Nickel Grain Type)

SPECIAL PROCESS ROLLS
GRADES "A," "B," "C" and "D"
(Chill and Grain Type)

AJAX DUPLEX ROLLS
(High Alloy Grain Type)

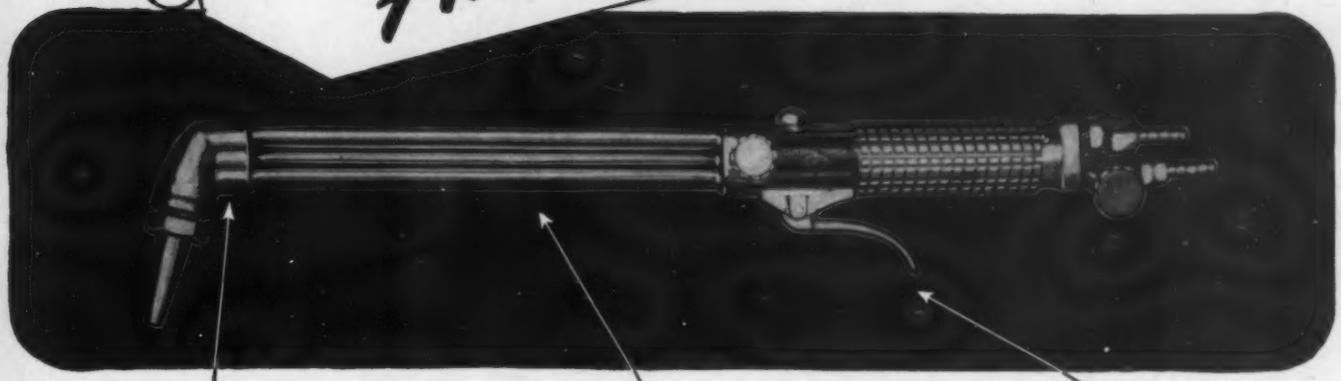
CLIMAX and AJAX ROLLS
(High Alloy Grain Type)

SPECIAL TUBE MILL ROLLS

LEWIS ROLLS

Again Available

. . . The Airco Series 9000 Cutting Torch with Monel Metal Head and Stainless Steel Tubes

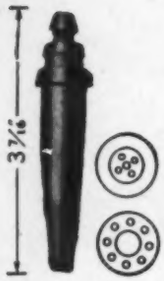


MONEL METAL HEAD for long trouble-free service; furnished with straight, 75°, or 90° angle heads in various torch lengths.

STAINLESS STEEL TUBES have greater rigidity and heat resistance — all connections are silver brazed to assure, permanent, leakproof service.

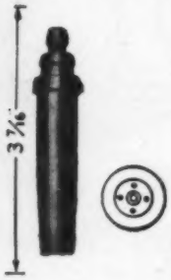
STAINLESS STEEL LEVER in a natural position for effortless operation.

. . . and in addition to these outstanding, long-wearing features, this torch has **GREAT** versatility. It can be used for all conceivable types of cutting operations by means of many interchangeable types of cutting tips — a few of which are shown here:



STYLE 144 — For General Hand and Machine Cutting

STYLE 181 — For Riser Cutting



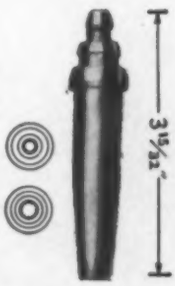
STYLE 197 — For Rivet Washing

STYLE 183 — Gouging, Removing Imperfect Welds, Grooving and Flame Machining

STYLE 195 — For Hand Cutting of Rivet Heads and Machine Cutting 45° Bevels

STYLE 209 — For General Hand and Machine Cutting with Oxygen and Propane or with Oxygen and Natural Gas

FOR COMPLETE INFORMATION ABOUT THIS VERSATILE TORCH, WITH ITS FULL COMPLEMENT OF TIPS, WRITE FOR BULLETINS ADC-617 AND ADG-1098. Address: Air Reduction, General Offices, 60 East 42nd St., New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, General Offices, Houston 1, Texas. Represented Internationally by Airco Export Corp.



AIRCO

AIR REDUCTION

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HEADQUARTERS FOR OXYGEN, ACETYLENE AND OTHER GASES...CARBIDE...GAS WELDING AND CUTTING APPARATUS AND SUPPLIES...ARC WELDERS, ELECTRODES AND ACCESSORIES

Rolling Mill equipment

Year-in, year-out efficiency with minimum down-time; that's the true measure of rolling mill performance. And it's the yardstick that brings leading mill operators back to Bliss for their important sheet and strip mill installations.

No rolling mill requirement is too large—or small—for Bliss' extensive engineering and manufacturing facilities. Bliss builds two-, three-, and four-high mills for hot and cold rolling, single stand, reversing, or tandem operation on ferrous or non-ferrous metals. You can look to Bliss, too, for cluster mills and a complete range of accessory mill equipment including mandrel type hot mill coilers, upcoilers, slitters, reels, etc.

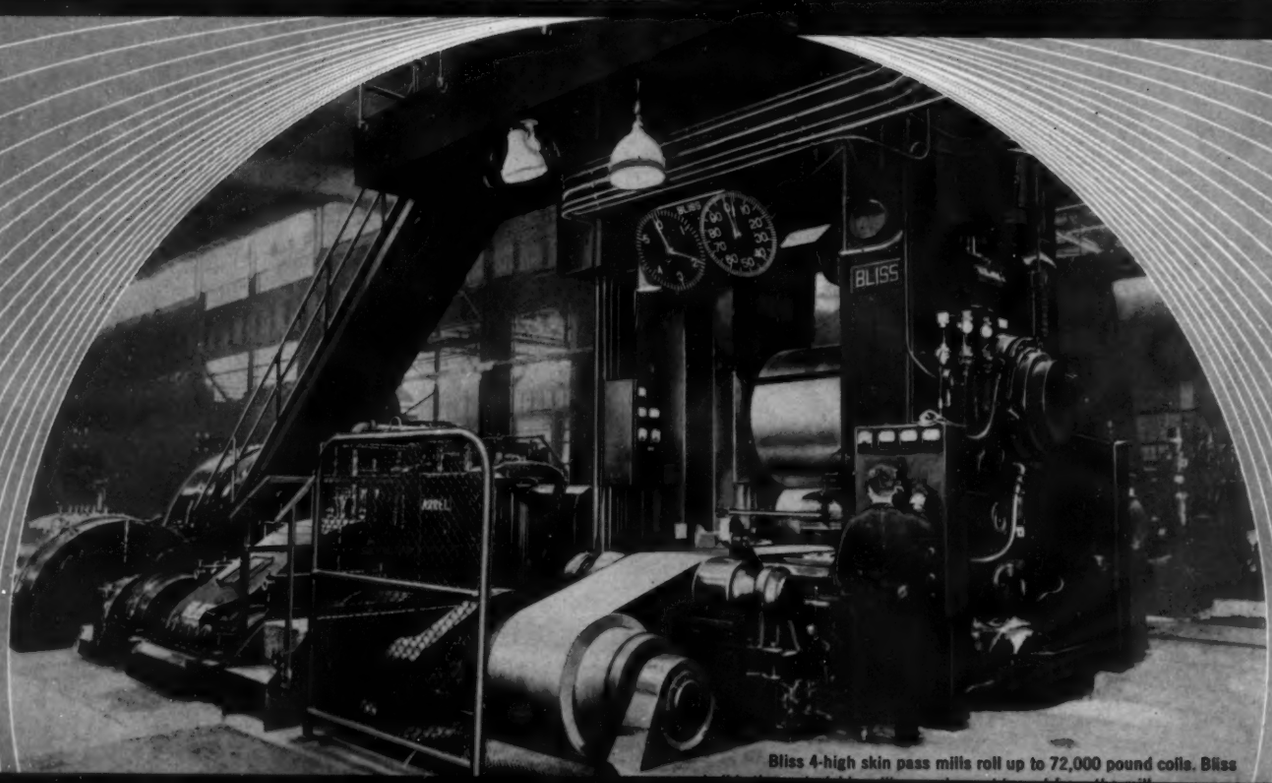
Have you a current rolling mill problem? Talk it over with Bliss.

with the long life-line

STAY AHEAD WITH *Bliss*

E. W. BLISS COMPANY
Salem, Ohio

- rolling mills
- mechanical and hydraulic presses
- can and container machinery



Bliss 4-high skin pass mills roll up to 72,000 pound coils. Bliss

BROSIUS STEEL MILL EQUIPMENT

Easily Operated

Brosius Chargers

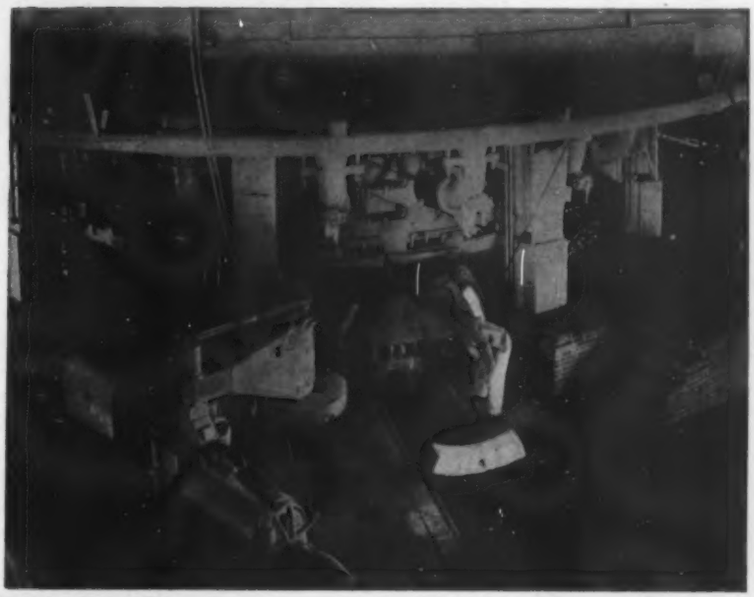
Brosius Auto Floor Charging Machines (tongs and box type) and Manipulators are built in capacities of from 2000 to 20,000 pounds. Pictured left is a 2000 pound Brosius Auto Floor Manipulator. It provides a multiple service of manipulating the piece under the hammer or press, and also charging and drawing the heating furnaces.

No tracks or runways are needed — just a good solid concrete floor. An electric motor travels the machine over the floor, while all other motions, including steering, are hydraulically actuated.

Brosius Clay Guns

Brosius Clay Guns are available for either Pedestal or Column mounting. With either mounting the boom drive is positive and the gun travels into and out of the hole at a uniform speed. No latching mechanism is required to hold the gun in the hole, as this is accomplished through a non-reversing worm and a magnetic brake on the swing motor.

All controls are located in the cast house, a Brosius Safety Feature which keeps all the furnace men out of the danger zone during the plugging operation.



Brosius Goggle Valves

Brosius Goggle Valves give efficient and dependable service. Valves having a clear opening of 42 in. and larger have two separate drives, one for operating the valve seats and one for swinging the plate. Valves having a clear opening of 36 in. and less are provided with a single drive. With either type, the swinging of the plate can be arranged for hand or motor operation.

OTHER BROSIUS PRODUCTS: Cinder Notch Stoppers; Flue Dust Conditioners; Coke Testing Tumbling Barrels; Soaking Pit Cover Carriages; Slag Granulating Mills.

Write for our new catalog and descriptive literature on all types of Brosius Equipment.

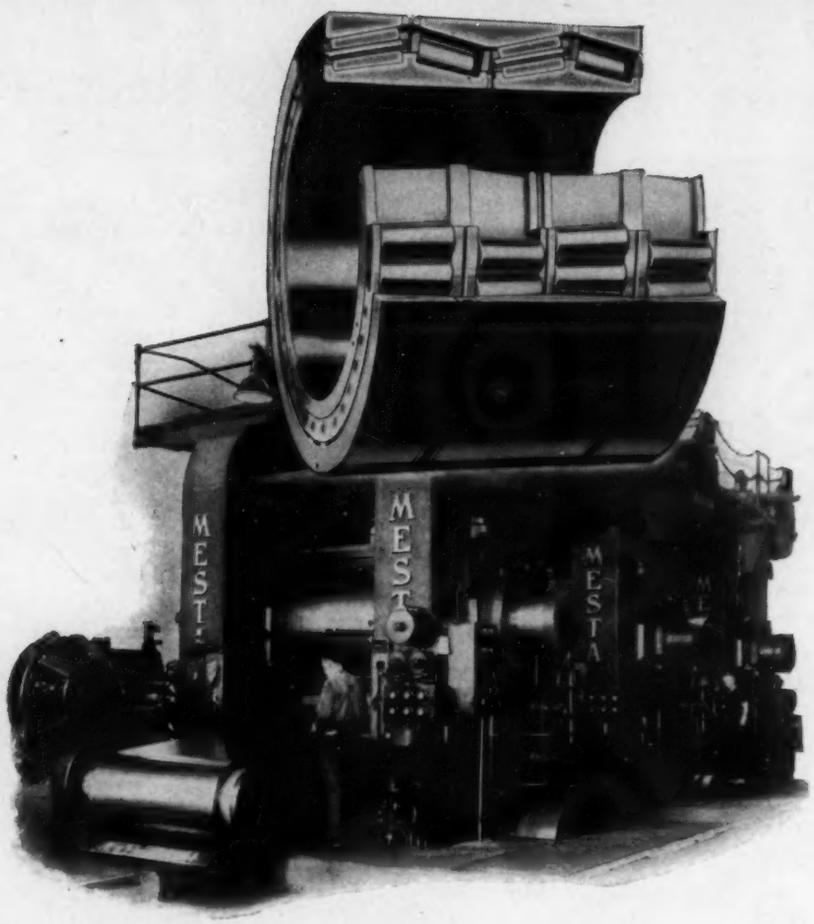
Brosius Equipment is covered by patents, allowed and pending, in the United States and Foreign Countries.

Edgar E. BROSIUS Company Inc.

Designers & Manufacturers of Special Equipment for Blast Furnaces & Steel Mills

SHARPSBURG Pittsburgh (15) PENNSYLVANIA

Brosius Equipment is constantly being improved to meet new and more difficult requirements of present-day production.



Roll out record tonnages...

by securing higher rpm on roll necks . . . increased neck diameter *and* greater bearing capacity . . . longer service life . . . reduced power requirements . . .

with Torrington Roll Neck Bearings.

These four-row tapered roller bearings are engineered for higher ID in proportion to OD, allowing greater roll neck cross-sections. Their radial and thrust capacity is increased through closer spacing of rollers, made possible by pin-type retainers. High nickel content alloy steel is employed for maximum resistance to shock, wear and fatigue.

Set new standards of production by standardizing on Torrington Bearings for heavy-duty equipment.

THE TORRINGTON COMPANY

SOUTH BEND 21, IND. TORRINGTON, CONN.

Offices in All Principal Cities

TORRINGTON BEARINGS

• NEEDLE • SPHERICAL ROLLER • STRAIGHT ROLLER • TAPERED ROLLER • BALL •

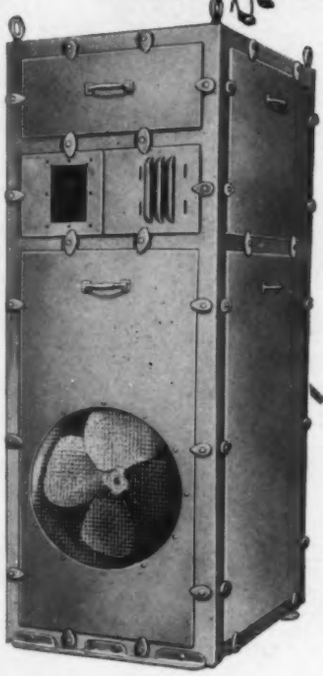
Presenting

4 New Models Lintern Aire-Rectifiers

These new models have increased capacities at no increase of space required on the crane. The behind-the-cab model is increased from 12,000 to 14,000 Btu, the footwalk model from 12,000 to 14,000 Btu and 18,000 Btu, and the big pit crane model from 24,000 to 27,000 Btu. The only dimensional change is an increase of 2 in. in height of the footwalk model.

You have the choice of four different capacities, in three sizes — not just one — which, experience has proved to us, are absolutely necessary to meet all requirements. In addition to increased capacities, these units have many minor refinements which facilitate servicing and lengthen their lives. With these Aire-Rectifiers you can do any desired conditioning job at the lowest possible cost.

Now is the time to check your operations for the size unit necessary to do a satisfactory job. Or, if you prefer, give us the ambient temperatures at cab location and we shall be glad to recommend the size. Ask for Bulletin No. AC 82147.



Lintern Aire-Rectifier Model 148 AC-14, 26 in. wide, 33 in. long, 72 in. high, weighing 1800 lb. Usually mounted behind cab. 14,000 Btu.

Lintern Air-Rectifier Model 148 AC-14-F (14,000 Btu) weighing 1800 lb and model 148 AC-18 (18,000 Btu) weighing 2000 lb. Both have the same frame size — 23 in. wide, 57 in. long, 58 in. high. Usually mounted on footwalk.

As an indication of the low maintenance to be expected with Aire-Rectifiers, a large steel company reports that during an entire month recently only 33 minutes delay for servicing was charged to the three Lintern Aire-Rectifiers operating in that plant. This user has had one unit for a year or more. The brief servicing time is typical with them as it is with other Aire-Rectifier owners.

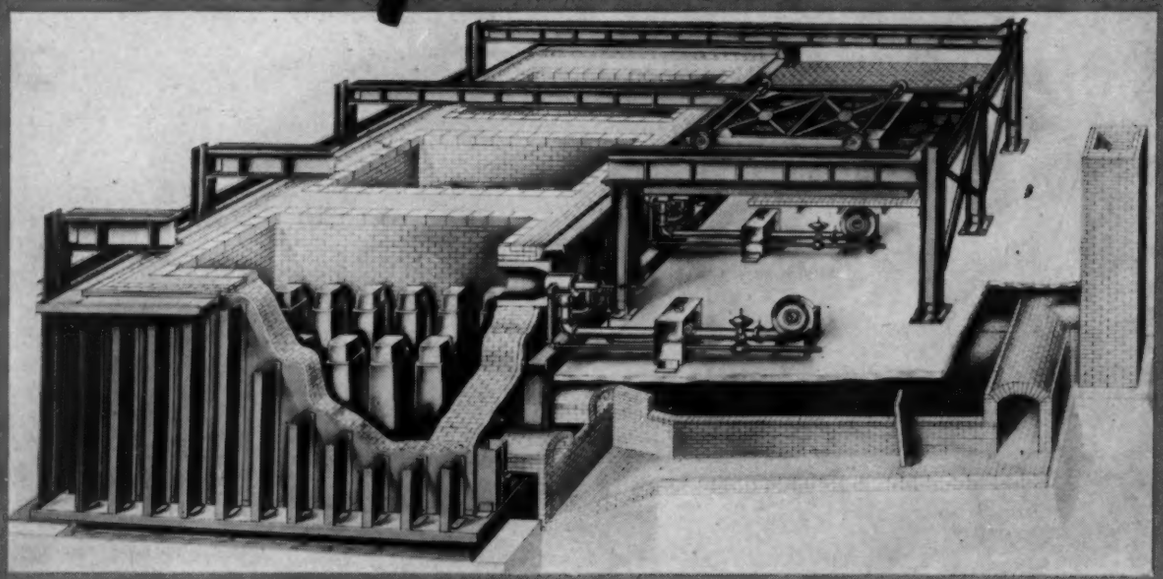
Lintern Aire-Rectifier 148 AC-27, 26 in. wide, 66 in. long, 62 in. high, weighing 2300 lb. 27,000 Btu.

THE LINTERN CORPORATION

94 LINCOLN AVENUE DAYTON, OHIO

Your NEW Headquarters for the Economical Solution to Difficult

heating problems



The Urquhart Combustion Process for Heating Furnaces, Soaking Pits, and Forge Furnaces

AN INSTALLATION of the Urquhart Combustion Process on Soaking Pits has shown a definite saving in construction cost, floor space, fuel, scale loss and maintenance, with uniform heating and greater yield. Bottoms were cleaned for the first time after twenty-one weeks of continuous operation.

Steel Processing Co.

Subsidiary of FORT PITT BRIDGE WORKS

KEYSTONE HOTEL BLDG., PGH., PA.

A Product of
UNITED ENGINEERING
AND FOUNDRY COMPANY
PITTSBURGH, PA.
Plants at PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON
Subsidiary: Adamson United Company, Akron, Ohio
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q., Canada
UE&FCO

Use your *OLD* tie-rods in your *NEW* pickling tank

NEW WOOD PICKLING TANK built by **The Hauser-Stander Tank Company,** *Cincinnati, Ohio. Its Monel tie-rods have already seen 7 years of continuous service in the old pine tank pictured at the left.*

Salvage of Monel rods both economical and practical, says HAUSER-STANDER TANK COMPANY, Ohio manufacturer

One test of a tie-rod's merit is its ability to keep a pickling tank tight.

Another, its ability to outlast the tank itself.

On both tests, Monel* tie-rods, nuts and washers show up exceptionally well.

So outstanding is their resistance to corrosive pickling solutions, that **The Hauser-Stander Tank Company** of Cincinnati, Ohio, frequently suggests re-use of Monel tie-rods in new tanks!

Note the illustrations on this page. One tank is new; one is old. *But the tie-rods are the same.* Hauser-Stander took them from the old pine tank where they had seen seven years of continuous service, and used them to bind the new tank.

On occasion, Hauser-Stander has taken Monel rods which have served in *two* wooden tanks, and put them into a *third.* It's possible to do this because corrosion-resistant Monel combines high strength and high yield point with high ductility. Even under severe conditions, Monel retains these properties. That's why it is also possible to take old tie-rods and fabricate them into hooks, eyebars or pickle pins.

When you order new tanks — or find it necessary to re-rod those you have — remember Monel. It's long-lasting. It's safe. It's economical.

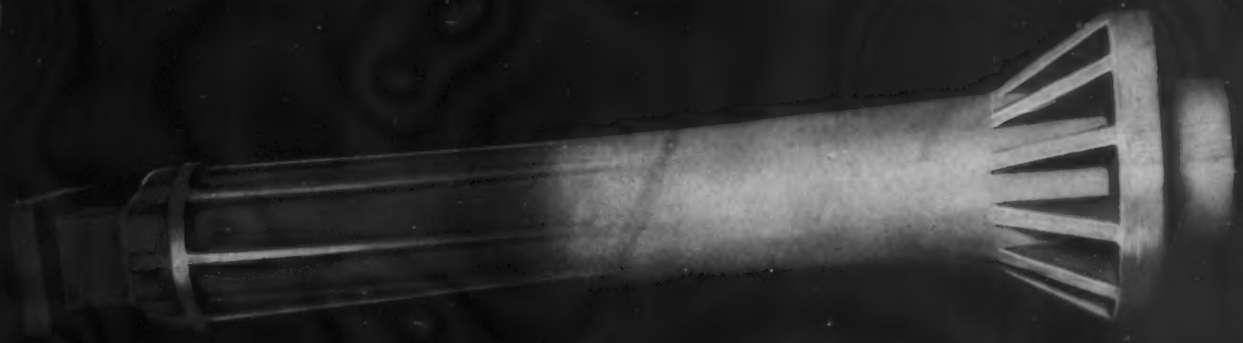
Monel

*Reg. U. S. Pat. Off.

EMBLEM OF SERVICE
NICKEL (INCO TRADE MARK) ALLOYS

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N.Y.

UNION PEELS STAND UP



UNDER THAT CONTINUOUS "ORDEAL BY FIRE"

Shown above are standard and special fluted peels, furnished either as rough castings or fully machined ready for installation. Double Life Head Charging Boxes are cast in ordinary carbon steel or "UNIVAN"—a nickel-vanadium alloy of exceptional shock-absorbing, heat-resisting qualities.

Except for the charge itself, no piece of unprotected metal is subjected to greater heat for a longer time than the peel. And, hot or cold, it must withstand severe shock and stresses as well. "Union" has developed for this tough service peels of heat and shock resistant alloys in designs that add months to their useful life . . . Glad to quote from your specifications.

UNION *Double Life Head* CHARGING BOXES

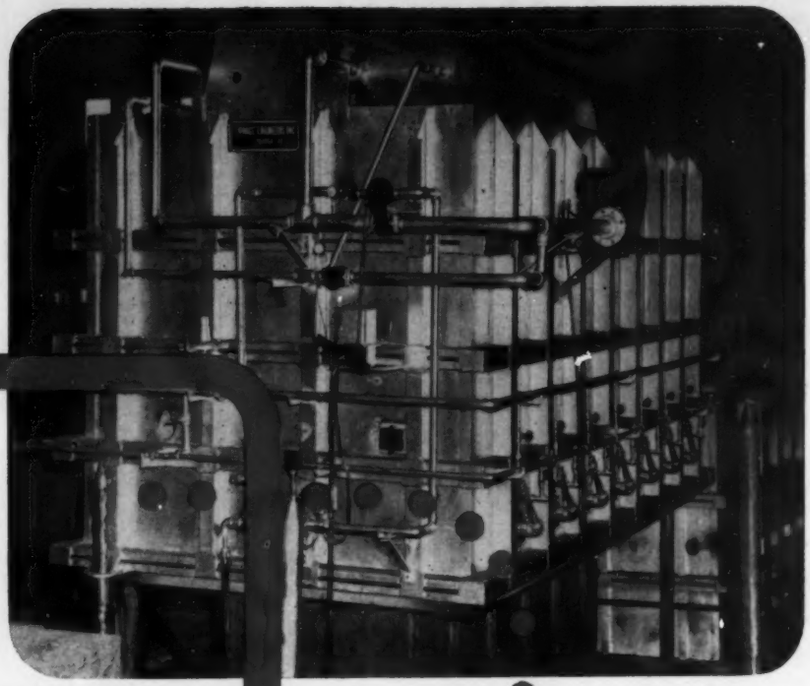
The hot-and-cold life of a charging box has been greatly extended by Union designers, engineers and metallurgists. The antiquated open type head has been replaced by an improved reinforced head which eliminates cracks and distortion . . . Whether you operate with 20, 25, 36 or even 50 cu. ft. capacity, we welcome the opportunity to prove that you can do a faster charging job for less cost with Union "Univan" Charging Boxes.

"UNIVAN"

UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX CO., PITTSBURGH, PA.

Cinder Pots • Slag Pots • Coupling Boxes • Spindles • Gears • Bells and Hoppers • Ingot Cars • Charging Cars • Annealing Boxes and Bases



When you need heat treating help your best bet is...
FURNACE ENGINEERS

Your heat treating problem will receive experienced and skilled treatment when you turn it over to Furnace Engineers, Inc. The FEI service covers the entire field of heat treating, from engineered design to operational checks. Your need will be completely fulfilled.

The FEI Patented Combustion System has increased production and lowered costs for almost every type of heat treating operation. You can take advantage of FEI's wide background of experience and knowledge by consulting us about your needs. Our equipment can utilize with equal efficiency natural gas, coke oven gas, clean producer gas, clean blast furnace gas, propane, oil refinery gas, butane, and can be changed from one to the other without any important preparations. Your inquiry will not obligate you in any manner. Why not write today?

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- Direct-Fired Cover Furnaces for annealing, spheroidizing, Normalizing and bright annealing of wire, rods, coiled strip, flat sheets and tin plate.
- For Heavy Coil Loads: Patented Convection Base, gives 2 to 4 times longer service.
- For Wire, Bar and Tube Mills: Galvanizing, Patenting and Normalizing Furnaces.
- For Pipe, Sheet and Job Plants: Hot Dip Galvanizing Furnaces.
- Car Type Furnaces, Rod Heating, Lead Quenching, Ladle Heating and Salt Bath Descaling Furnaces.
- Continuous Quenching and Tempering Furnaces—Quench Tanks, Water or Oil.
- Soaking Pits.
- Special Application Furnaces for both ferrous and non-ferrous industries.

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FURNACE ENGINEERS, Inc.

FOREIGN REPRESENTATIVES: For Canada: Salem Engineering (Canada) Ltd., Toronto, Ont.
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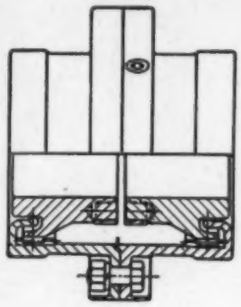
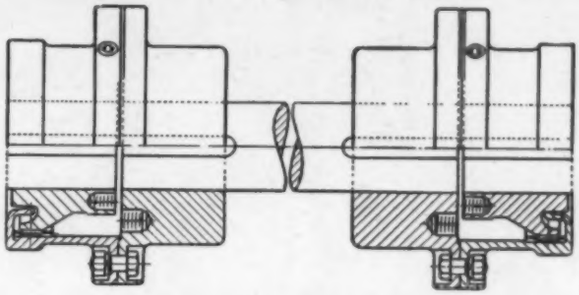
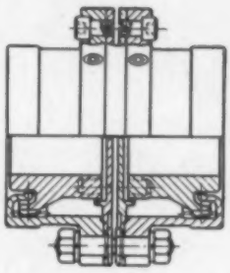


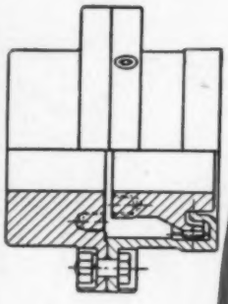
STANDARD



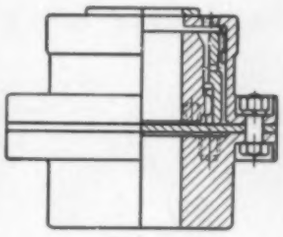
FLOATING SHAFT



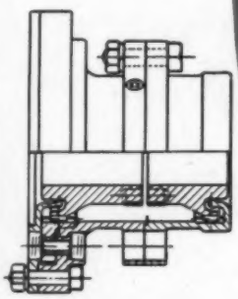
BREAKING PIN



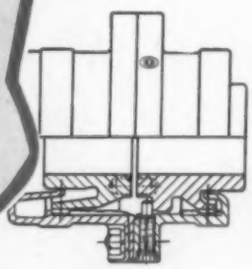
SINGLE ENGAGEMENT



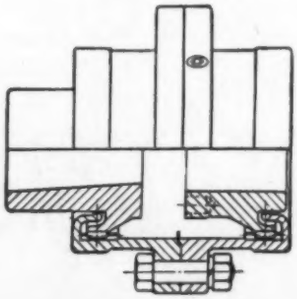
VERTICAL



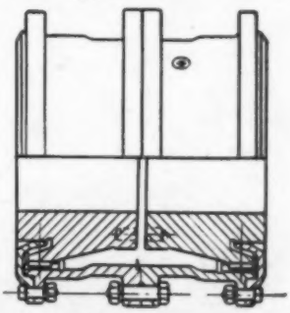
SHEAR PIN



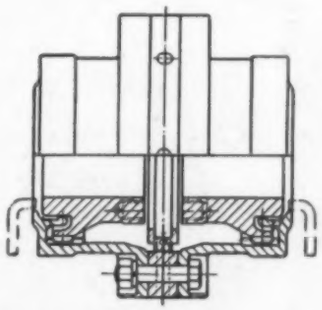
CUT-OUT



MILL MOTOR



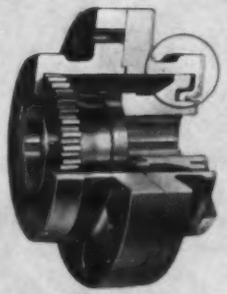
HEAVY DUTY



CONTINUOUS LUBRICATING

WHATEVER YOUR CHOICE . . .

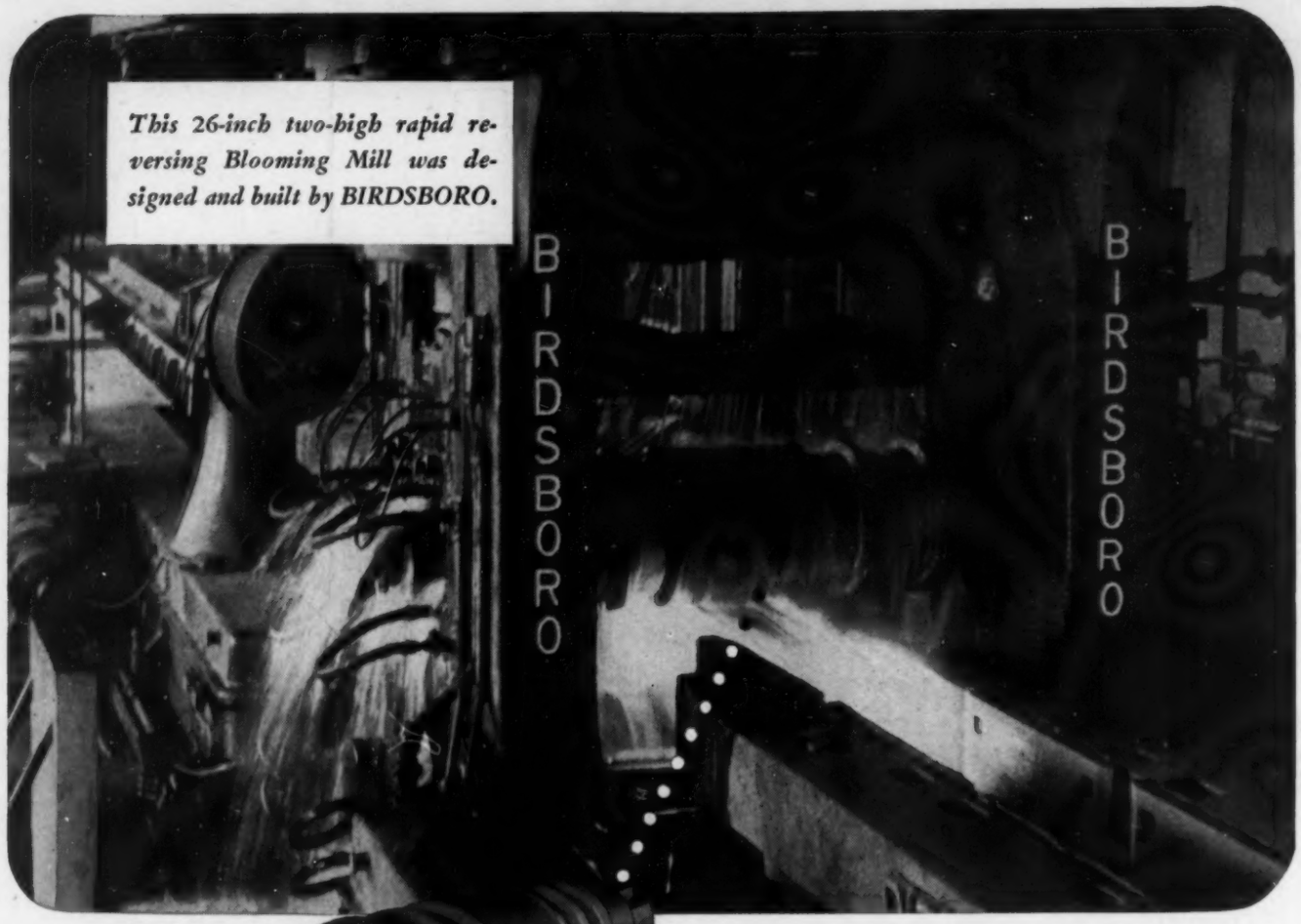
FAST'S GIVES YOU THIS EXTRA SAFEGUARD!



ALL - STEEL CONSTRUCTION! NO PERISHABLE PARTS! Those statements apply to Fast's self-aligning couplings — uniquely designed to give you uninterrupted power transmission. The *exclusive* "rocking bearing" (circled) is an example of Fast's thoroughness. It provides a positive metal-to-metal seal for the load-carrying oil, permanently protecting it against moisture, dust and grit. No perishable packing rings are used. There's nothing to wear, nothing to fail. ¶ Years of engineering experience, Koppers' high standard of workmanship and unexcelled coupling service pay off in longer machine life, lower upkeep costs and minimum shutdown losses . . . when you choose your Couplings from Fast's big, complete line. Prompt delivery. Write for our catalog to: Koppers Co., Inc., Fast's Coupling Dept., 219 Scott St., Baltimore 3, Md.

K KOPPERS

FAST'S *self-aligning* COUPLINGS



This 26-inch two-high rapid reversing Blooming Mill was designed and built by BIRDSBORO.

BIRDSBORO ROLLS

Keep Rolling For High, Continuous Production

There's less downtime to eat up your profits and increase maintenance costs when Birdsboro "Special A" DIAMONDITE rolls are on the job. They are designed and built for

1. GREATER STRENGTH—to withstand higher mechanical stress.
2. INCREASED HEAT RESISTANCE—to reduce fire-cracking and wear.
3. TIGHTER SURFACE GRAIN—to hold "mirror" finishes longer.

Birdsboro's individualized roll service insures you of rolls with the right combination of analysis and physical to do your specific job. Our engineers would like to discuss your roll problems with you and work out a practical solution to give you highest roll efficiency at minimum cost.

SPECIAL
PATENT PENDING
DIAMONDITE
BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY
BIRDSBORO, PA.

BUILDERS OF: Rolls, Steel Mill Equipment, Hydraulic Presses, Special Machinery, Crushing Machinery, Steel Castings

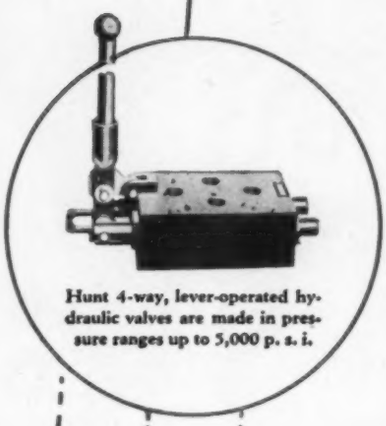
Birdsboro Steel Foundry & Machine Co. • Birdsboro, Pa.

BIRDSBORO
ROLLS

HUNT

Quick-As-Wink Valves

give safe, positive control in Crown Cork and Seal Strip Mill

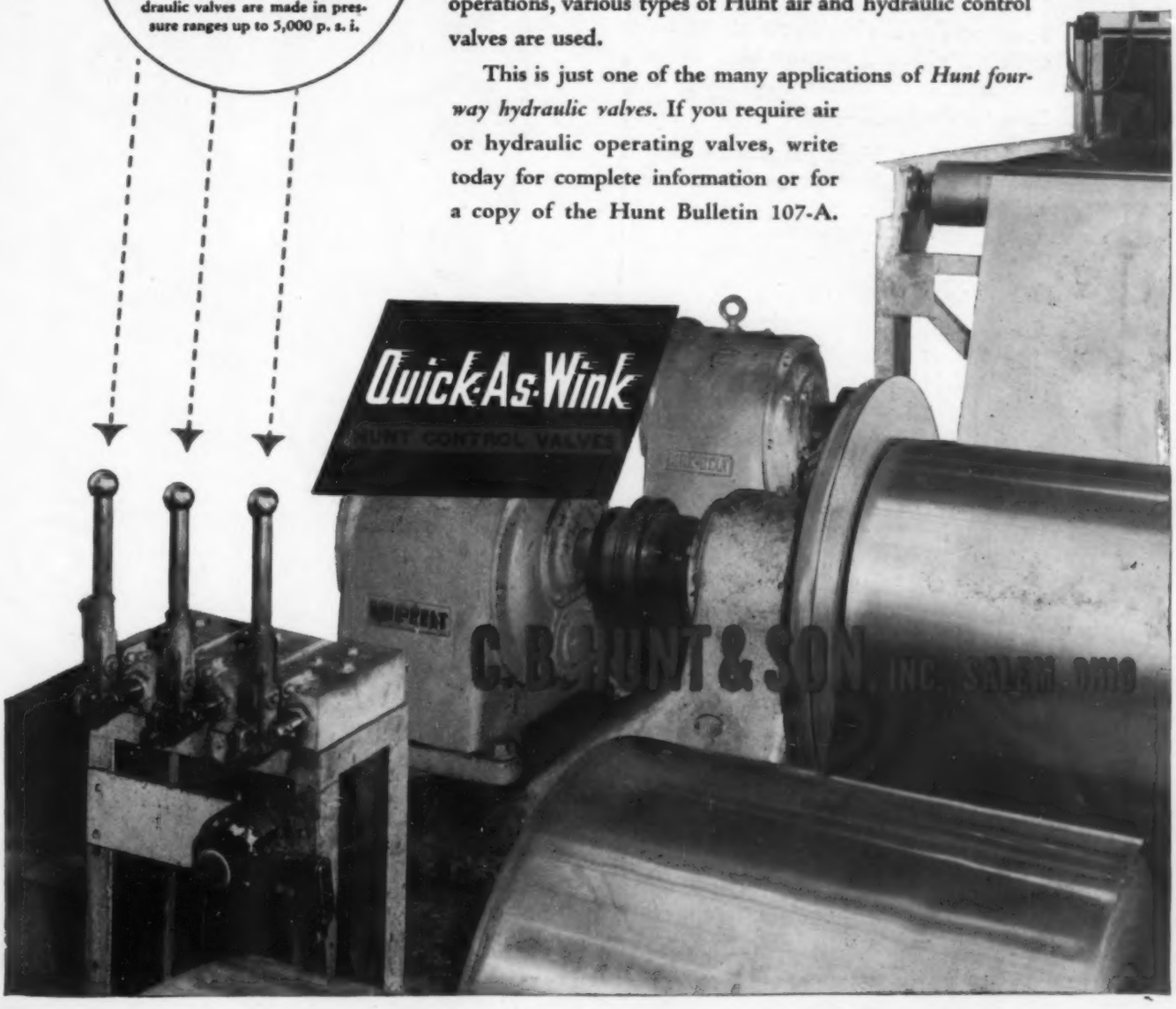


Hunt 4-way, lever-operated hydraulic valves are made in pressure ranges up to 5,000 p. s. i.

● This illustration shows three 4-way, neutral position valves handling 1000 pounds pressure and used for controlling coil holders at entry end of continuous strip annealing furnace. The two end valves operate the reel heads on the clamping mechanism while the center valve operates the coil elevator.

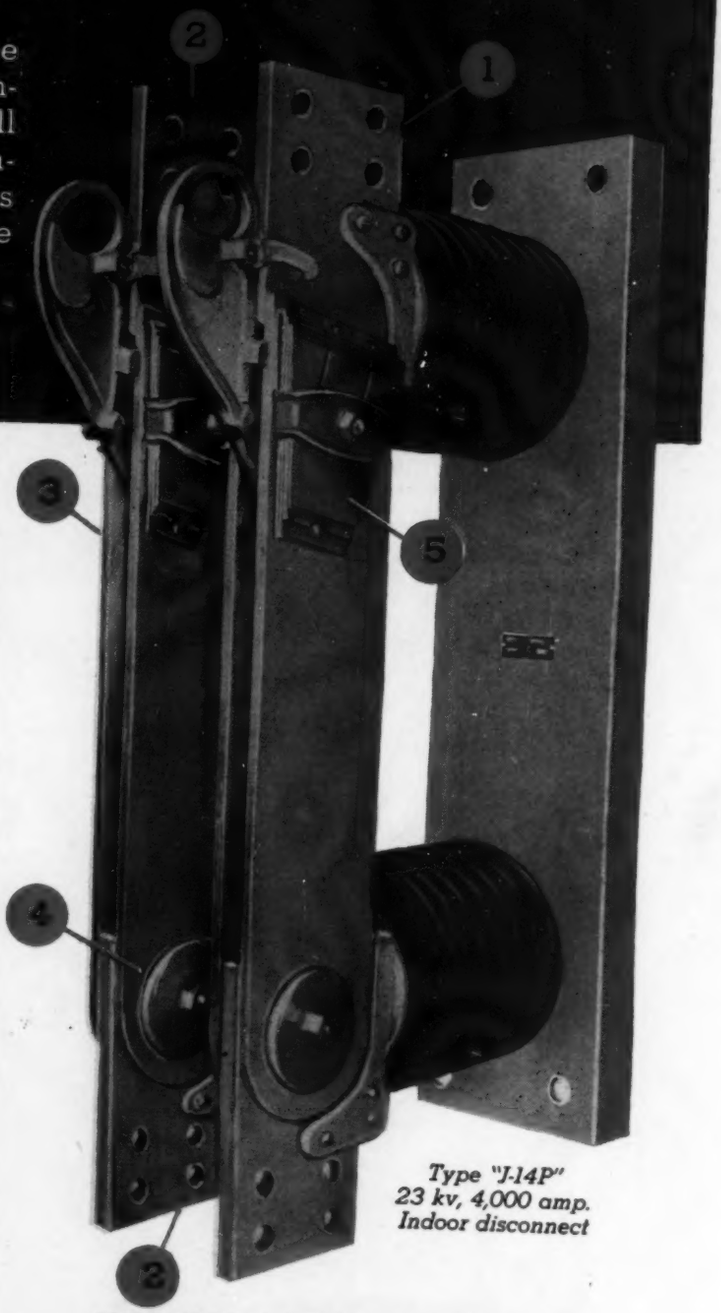
The Crown Cork and Seal Company are the world's largest producers of bottle caps and in their many diversified manufacturing operations, various types of Hunt air and hydraulic control valves are used.

This is just one of the many applications of *Hunt four-way hydraulic valves.* If you require air or hydraulic operating valves, write today for complete information or for a copy of the Hunt Bulletin 107-A.



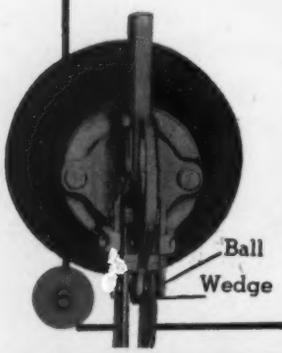
FOR HEAVY DUTY SERVICE 2000 AMPERES AND OVER

You can rely on DELTA-STAR type "J-14P" indoor hook operated disconnecting switches to — (a) carry full load current continuously – (b) withstand full short time current values without damage – (c) open and close with surprising ease.



Type "J-14P"
23 kv, 4,000 amp.
Indoor disconnect

1. Liberal design with ample material for heat dissipation – no cast current carrying parts.
2. Straight-line current path.
3. Floating double-blade construction with individually sprung high pressure button contacts — provide positive contact alignment.
4. Annular-ring high pressure hinge contact — constant pressure for all blade positions.
5. Heavy cantilever leaf springs – provide constant pressure.
6. Ball type pressure release — high pressure is released by pull on large hook-ring, leaving sufficient pressure for wiping action on contacts.



Available in standard ratings — 7,500, 15,000 and 23,000 volts, 2,000 thru 5,000 amperes, in all standard strength classes of insulation. For complete listing, ask for publication 4401.

YOUR SYSTEM DESERVES THE BEST — YOU CAN GET IT AT NO GREATER COST

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CANADIAN ASSOCIATE
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Toronto 13, Canada

℞ FOR GROWING PAINS

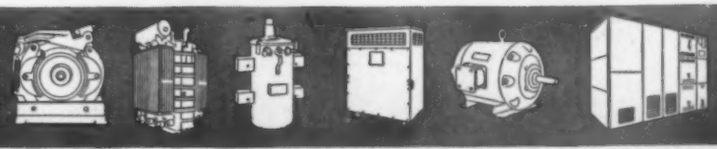
The new Wagner ALL-IN-ONE Unit Substation is the remedy for industrial plants suffering the "growing pains" of expanding power needs. Engineered as a single unit, ready to connect to the line, this substation greatly simplifies the planning, purchase and installation of power distribution equipment. The ALL-IN-ONE comprises a *complete* substation to be placed at load centers to shorten low-voltage feeder lines, thus effecting a substantial saving of copper, and at the same time improving voltage regulation of lighting and power circuits.

Wagner ALL-IN-ONE Unit Substations are built to the same high standards of quality and dependability which have characterized Wagner transformers for over half a century. Users of Wagner transformers also profit by our quick, convenient, nationwide service facilities.

Regardless of what your transformer problems may be, a Wagner engineer is ready to help you. Trained field engineers are available at any of our twenty-nine branch offices, located in principal cities. Wagner makes a complete line of transformers and will gladly send bulletins upon request. Address Wagner Electric Corporation, 6483 Plymouth Avenue, St. Louis 14, Mo.

Wagner Electric Corporation
EST. 1891

Consult Wagner Engineers on All Transformer Problems



T47-10

BRIDGE BRAKES • POWER AND DISTRIBUTION TRANSFORMERS • MOTORS • UNIT SUBSTATIONS

ELECTRICAL AND AUTOMOTIVE PRODUCTS

'Surface' OIL-FIRED

Modern, One-Way Fired, Recuperative Type featuring control of temperature and combustion to give all the engineering and operating advantages offered in the popular 'Surface' One-Way Gas-Fired Pits.

'Surface' engineered and built its first oil-fired pits in 1934. Since that date there has been a total of 80 'Surface' oil, oil-gas, or oil-tar fired pits installed in plants of leading steel producers.

These 'Surface' Oil-Fired Pits have lowered operating costs . . . solved seasonal fuel problems, or partial capacity operation, and made fuel storage possible, where such problems were of great importance to the operator.

Again, 'Surface' has proved ability to meet industry's needs by providing equipment to accomplish a desired result. This flexibility in equipment application has simplified operation and lowered production costs for operators.

In addition to one-way fired soaking pits, 'Surface' has a complete line of heating and heat treating equipment including slab heating furnaces—billet reheating furnaces—continuous heat treating furnaces for plate—continuous strip annealers and normalizers—pit-type convection furnaces for annealing rod, wire or strip in coils, high alloy rod and bar, atmosphere annealing furnaces of car-bottom lift-cover type—bright annealing and normalizing furnaces for tubing—stress relief furnaces—wire patenting furnaces—annealing covers, and the foremost equipment in prepared atmosphere generators for practically every heat treating operation.

It will pay you to discuss your heating and heat treating problems with a 'Surface' engineer.

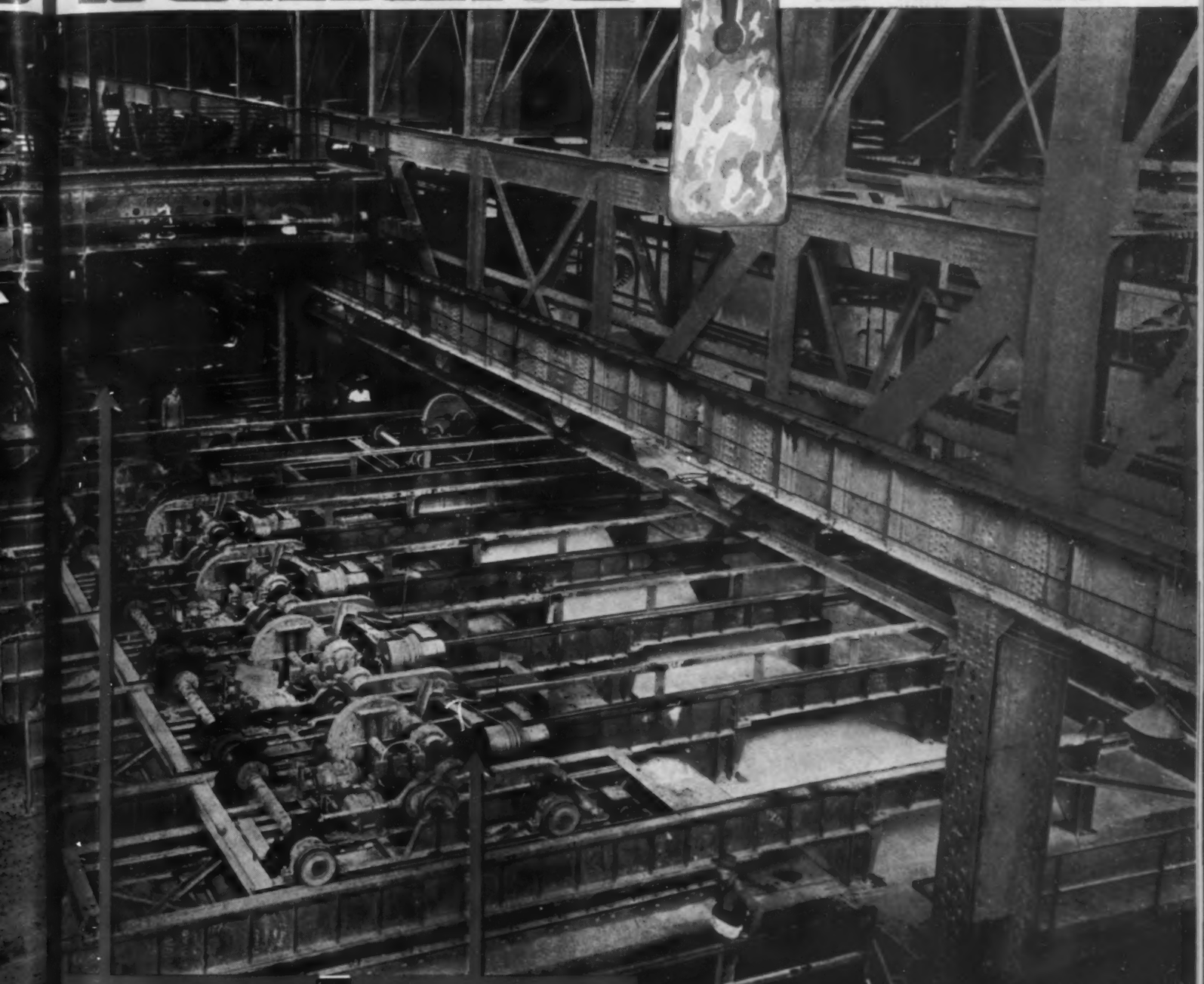
Above: A most recent 'Surface' Oil-Gas One Way Fired Soaking P installation at Cia Fundidora de Fierro, Monterrey Mexico.

'Surface'

SURFACE COMBUSTION CORPORATION

TOLEDO 1, OHIO

SOAKING PITS



6
REGENERATIVE TYPE PITS WITH TOTAL CAPACITY OF
36 INGOTS
GAS-FIRED *ONLY*

6
'SURFACE' ONE-WAY FIRED PITS WITH TOTAL CAPACITY OF
84 INGOTS
OIL-GAS FIRED

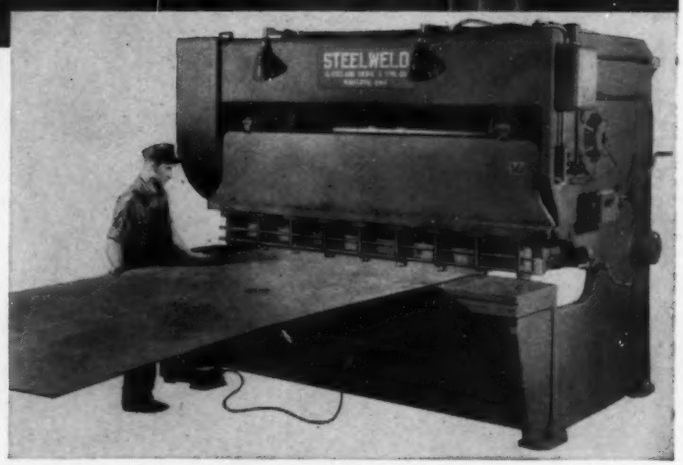
'Surface' Increased Installed Capacity 133%

← In the foreground the above photograph, the battery of six 'Surface' One-Way Oil-Gas Fired Soaking Pits has a total installed capacity, under the service of the pit crane, of 84 — 22 in. x 24 in. ingots. In the background of the same photograph is shown six regenerative type pits with a total installed capacity of only 36 ingots. Therefore, in the same size area, between the building columns, 'Surface' has provided an *increased installed capacity of 48 ingots.*

KNIFE CLEARANCE *Easily Adjusted* FOR ANY THICKNESS . . . . .

THERE is a direct relation between thickness of plate cut and clearance between knives for most satisfactory results. To properly set this clearance when changing from one plate thickness to another has been made extremely simple in Steelweld Shears.

The need of moving the shear bed, adjusting various nuts, testing the knife clearance with feelers, etc., has been eliminated. Such bothersome, time-consuming work has been reduced to the mere turning of a convenient crank. A large dial indicator indicates the clearance in thousandths of an inch and also shows the plate thickness that may be cut for any knife setting. Because knife adjustment has been made so easy, operators willingly make it on Steelweld Shears and thereby get the best possible cuts for every plate thickness—and knives remain sharper for longer periods.



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CATALOG No. 2011 gives construction and engineering details. Profusely illustrated.

THE CLEVELAND CRANE & ENGINEERING CO.

5002 EAST 82nd ST. WICKLIFFE, OHIO

STEELWELD PIVOTED BLADE SHEARS

Crops *and* Shorts

CONTINUED steel shortages are increasing the trend of purchases of steel plants by steel consumers. Driven by the needs of their production lines, quite a few steel users have entered the steel business. Most recent purchase was that of the Phoenix Iron Company by a syndicate of 25 manufacturers who had previously purchased Apollo Steel Company. The Phoenix purchase was dictated by the necessity of obtaining sheet bars to supply the Apollo sheet mills. The new syndicate is known as The Phoenix-Apollo Steel Company.

▲

INCOMPATABILITY, the grounds for so many divorces, occurs when the husband loses his income and the wife loses her patability.

▲

BRITISH Foreign Secretary Ernest Bevin has come up with a plan for solving the financial plight of his country as well as that of the rest of the world. All that is necessary, according to Mr. Bevin, is that the United States share its stock of gold, which it bought to a great extent from the rest of the world, with the rest of the world. Certainly, we can lay no claim to expertness in international finance, what with all our personal troubles in balancing our own accounts, but we fail to see any cure-all in Mr. Bevin's proposal. We still subscribe to the old fashioned theory that everyone — individuals, communities, states and nations — must not spend more than he earns. And he cannot actually earn more than he produces. Short working hours, high wages, three cars in every garage are lovely — we'd enjoy them, too. But no one has yet proved that outgo can continuously exceed income without coming to grief.

▲

THE safety record of the steel industry continued to improve through 1946. According to the American Iron and Steel Institute, the industry's 1946 accident frequency rate was 7.19 accidents per million man-hours, the lowest for the past five years and 46 per cent better than the average of 13.4 for all industries in 1946. The steel industry ranked fifth safest in the frequency rating, being topped by the communications, aircraft manufacturing, tobacco and glass industries.

▲

DON'T tell your wife, but a Kansas City College specialist in home management estimates that the average housewife washes six tons of dishes in a year.

OCTOBER 5–11 has been designated as fire prevention week. We have approximately 1,700,000 fires each year. About 600,000 of these are building fires. Almost half of the later occur in dwellings — about one every two minutes. A survey of the principal causes of dwelling fires shows smoking and careless use of matches to be responsible for 119,000 fires per year, defective heating equipment and flues for 85,000, defective wiring and misuse of electrical equipment for 47,000, inflammable roofs for 39,000, and careless handling of flammable liquids for 28,000. The element of carelessness is obvious in the vast majority of cases — carelessness that is draining our pocketbooks just as surely as the high taxes about which we fuss so much. No one but the individual is vetoing a cut in fire expense.

▲

AN inscription on the wall of a factory in Ashville, N. C., says: God gave man five senses — touch, taste, sight, smell, and hearing; the successful man has two more, horse and common.

▲

THE Industrial Furnace Manufacturers Association has announced a prize contest for the best paper describing advantages obtained by the use of modern industrial furnaces, kilns and ovens published in a trade paper in the United States between October 1, 1947 and September 30, 1948. The competition is open to all except those connected with the furnace industry. Prizes are $1000, $300, and $200, respectively, for first, second and third places. Papers published in The Iron and Steel Engineer are eligible for this contest, and in addition, may also win the Kelly award offered by the Association of Iron and Steel Engineers. "Thar's gold in them thar hills" for engineers who have a story to tell. Sharpen your pencils and send us your brain-child.

▲

A YEAR or so ago, steel men were being awarded medals for their excellent accomplishments in meeting the requirements of the war program. Today they have returned to their more usual role of whipping boys. Current government hearings on steel capacity and FTC hearings on price schedules are making the boys feel more at home. In several quarters the industry is being painted as a greedy Scrooge. It is difficult to battle such hate campaigns, and the industry might advantageously sharpen up its public relations activities. Perhaps it isn't enough to sit back in righteous dignity, feeling that the truth will conquer — perhaps a little ballyhoo would help.

▲

THE radio comedian Harry Hershfield has a plan to make Sunday driving safe: Take off the road all the cars that aren't paid for.

▲

A LOT of publicity has been given to our "unprecedented prosperity." Actually, the purchasing power of disposable national income has declined almost steadily since early in 1945. Considering the rise in living costs and in taxes, it now requires twice as much income for the average person to maintain the living standards of the prewar period. Despite record-breaking income, many consumers are drawing on savings and running into debt.

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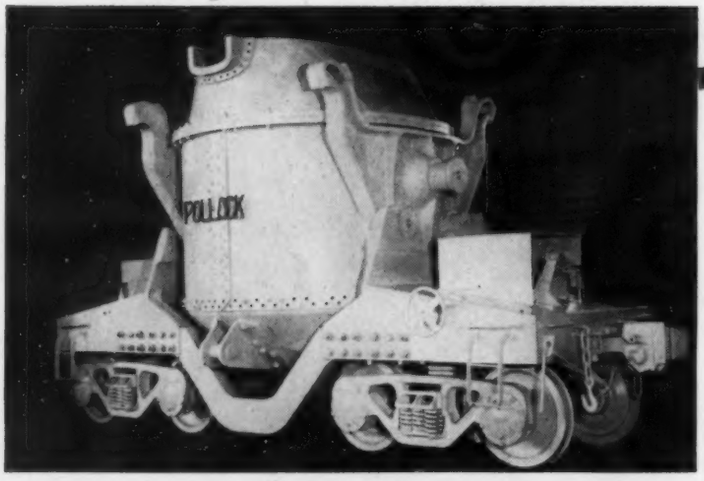

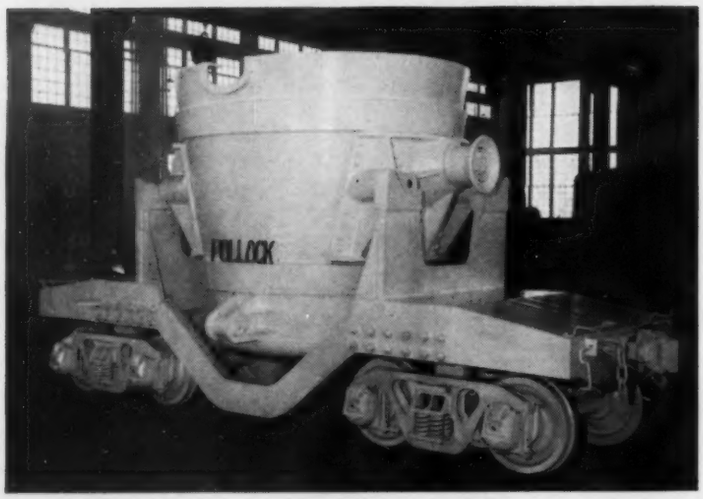

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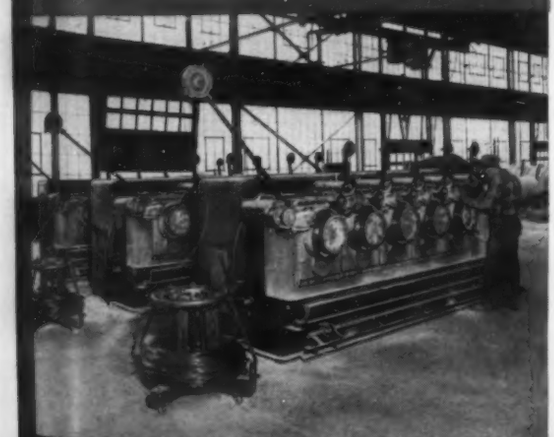

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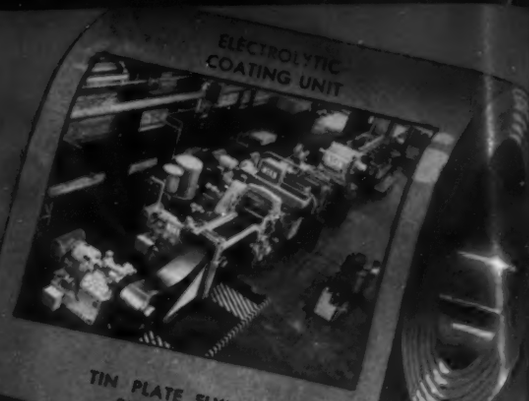

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Iron and Steel ENGINEER

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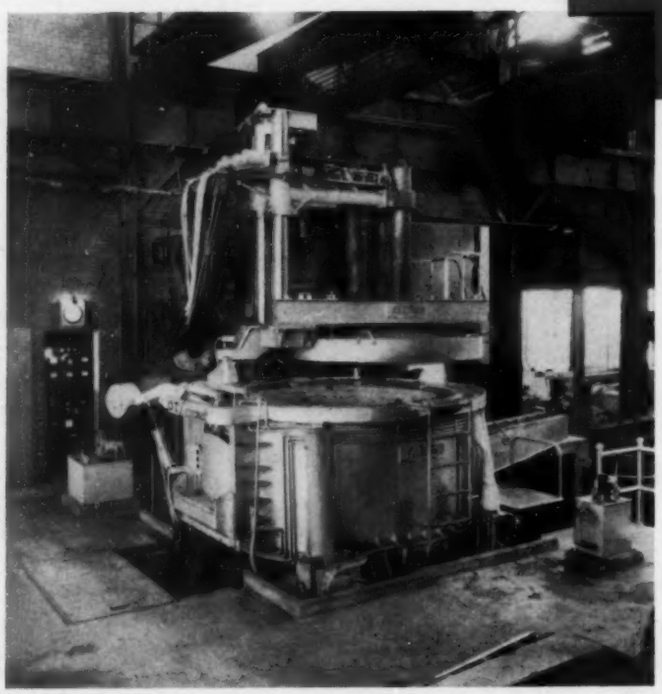

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REDUCING MAINTENANCE OF *Collector Assemblies*

. . . . proper mechanical design is of particular importance in dirty and dusty locations . . . .

By C. E. BAXTER
Assistant Chief Electrician
Blast Furnace Division
Great Lakes Steel Corporation
Ecorse, Michigan

▲ THE maintenance of electrical equipment in large industrial plants is a subject upon which many words have been written. Most plans advocate periodic testing of motor and control circuits, regular inspection of equipment, replacing of worn contacts, regular cleaning, etc., with the general idea of locating and eliminating potential sources of trouble before it can occur. In many industrial plants the majority of the electrical equipment is used to drive machine tools, conveyors, etc., which are located indoors and in fairly clean locations. Periodic testing and overhauling presents no problem in such plants because even though the plant is in continuous operation, one machine may be shut down for some time without seriously hampering production. Blast furnace and coke plant maintenance departments have a vastly more difficult task. In addition to extremely dusty and dirty atmospheres, we have gas conditions which cause rapid deterioration to all exposed copper. Thorough periodic testing is not possible on much of the equipment because it is never shut down. Several of the motors in our by-products plant have been running almost continuously since they were installed. A few minutes delay on a fast moving blast furnace necessitates checking the blast and causes considerable operating confusion and loss in production. The first duty of the blast furnace maintenance electrician on a trouble call is, therefore, to get the equipment back in operation, even if it is necessary to work a contactor by hand or close a contact with a screwdriver. Temporary or permanent repairs are then made while the equipment is in operation. The good housekeeping element of electrical maintenance is one which from outward appearances might seem seriously neglected around a blast furnace. A switchboard which has been thoroughly cleaned may be found covered with dust a few hours later, depending upon which way the wind blows and how the furnace is acting. Recognizing that dust, dirt and moisture are probably the most powerful enemies of electrical equipment, we attempt to keep things clean. Maintenance programs which

Figure 1 — The revised design of the collector shoe assembly eliminated many of the troubles of the original design.

Presented before AISE Detroit District Section Meeting, November 12, 1946

incorporate regular inspection, cleaning and testing are highly recommended.

In order to give the maintenance man more time for routine inspection it is always advisable to make a thorough study of any piece of operating equipment upon which there are repeated trouble calls. Sometimes a particular piece of electrical equipment causes continuous trouble because its mechanical design is wrong. This statement may sound strange in a paper purporting to deal with electrical maintenance. But if we consider to what extent the proper functioning of electrical equipment depends upon leverage, spring tension, friction, strength of materials, etc., we see that mechanical design may become very important indeed.

Several years ago our blast furnace plant was greatly enlarged by the addition of a new furnace and a by-product coke plant. Because of limited space, the plant being located on an island, it was necessary to use two ore storage yards. The storage yards are connected by a trestle in the form of the letter U. Ore transfer cars loaded by overhead cranes and unloaded by opening the car hopper doors, are used to transport ore to the furnace bins or to the ore storage yards as required. The transfer cars are driven by 250 volt direct current electric motors, power being supplied through collector shoes sliding on 40 lb steel rails mounted one above the other on six inch centers, and with the ball of the rail forming the contact surface. The new transfer cars when delivered were equipped with collector shoes which seemed to be very well designed from every engineering standpoint. However, after a short period of operation we began to have frequent trouble calls because of loss of power on these cars.

This condition was caused by a combination of operating factors which were impossible to foresee. Wear on car axle bushings and wheel flanges and on the track rails allowed an increasing amount of side motion of the trucks. Unequal expansion and contraction of the steel work of the trestle and in the power and track rails themselves caused variation in the spacing of the power rails with respect to the track rails. The springs in the collector shoes lost some of their tension. On account of their design, each collector shoe assembly formed a pocket for small pieces of ore which sometimes jammed the moving parts. All of these factors combined to cause a condition in which the collector shoes did not have enough side travel to insure good rail contact at all times. Since rail wheel and axle bushing wear were apparently not excessive, the most economical solution to the problem seemed to lie in providing some form of collector shoe arrangement that would allow more shoe travel and still be adjustable. A search of manufacturers catalogues revealed no collector rigging that would meet our requirements without extensive alterations. It was decided to experiment with an arrangement of our own design.

Two collector arms of maple 4 inches square and 20 and 26 inches long are fitted with angle iron clips at the bottom to hold the original collector shoe castings. They are supported by pins at the top ends from an angle iron frame, welded to the car truck frame at an elevation about 24 inches above the lower power rail. A piece of ¾ inch all thread pipe screwed through a hole in the arm forms a bearing for the pin. When hanging free,

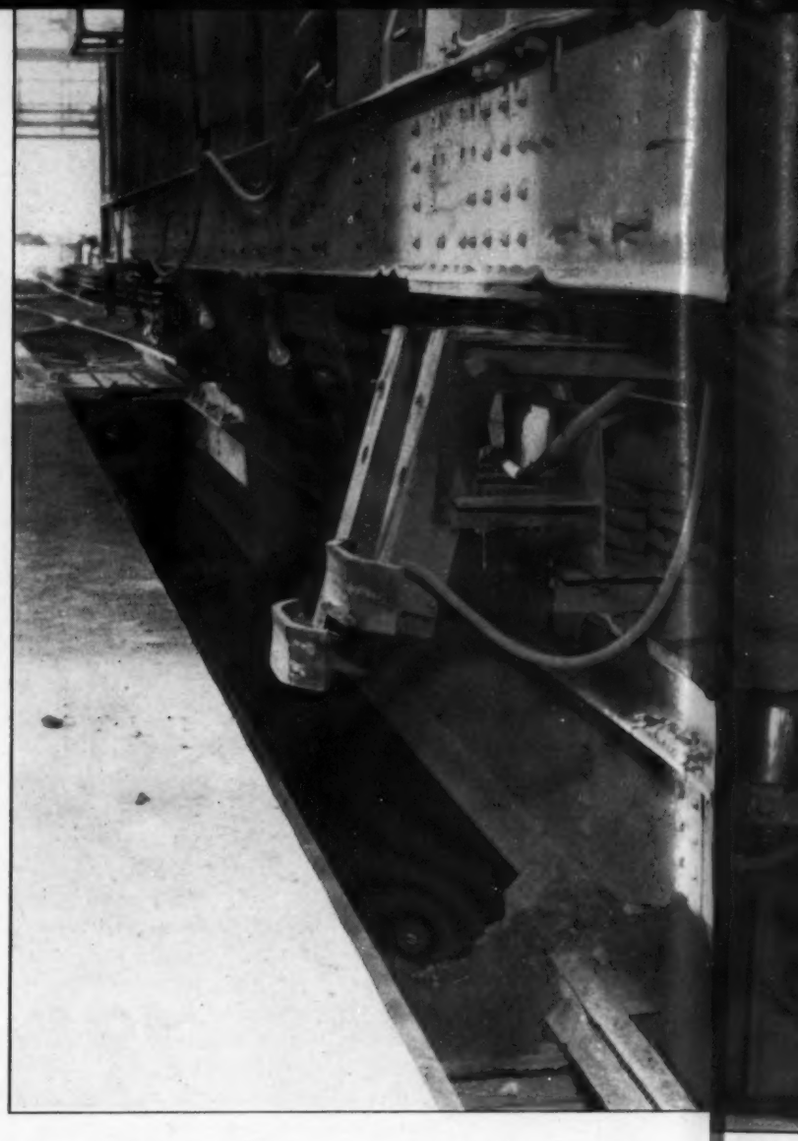


Figure 2 — A spring was selected for the collector assembly which gave proper contact conditions through the range of rail spacings.

these arms support the collector shoe castings so that each is about one inch away from the surface of its respective power rail, and free to swing toward or away from it. Two pieces of angle iron welded to the truck frame about 14 inches below the top frame, support a piece of channel iron with the web in a vertical plane. This channel iron has two slotted holes which line up with the two collector arms. A bolt extends through the collector arm and through the slotted hole in the channel. A coil spring with centering washers is supported by the bolt, and inserted between the collector arm and the channel iron. Locknuts on the bolt may be moved to limit and adjust the side travel of the shoe. Pieces of angle iron welded to the channel iron serve as guides and prevent side motion of the wooden arms as the car moves along the track. Flexible power cables are bolted directly to the collector shoe castings. After some experimenting we found a spring which gave us the right compression and sufficient flexibility to keep the shoes in good contact with the power rails through all the varying conditions of rail spacing. This arrangement has proven very satisfactory. Worn collector shoes are replaced in a few minutes by simply pulling two large

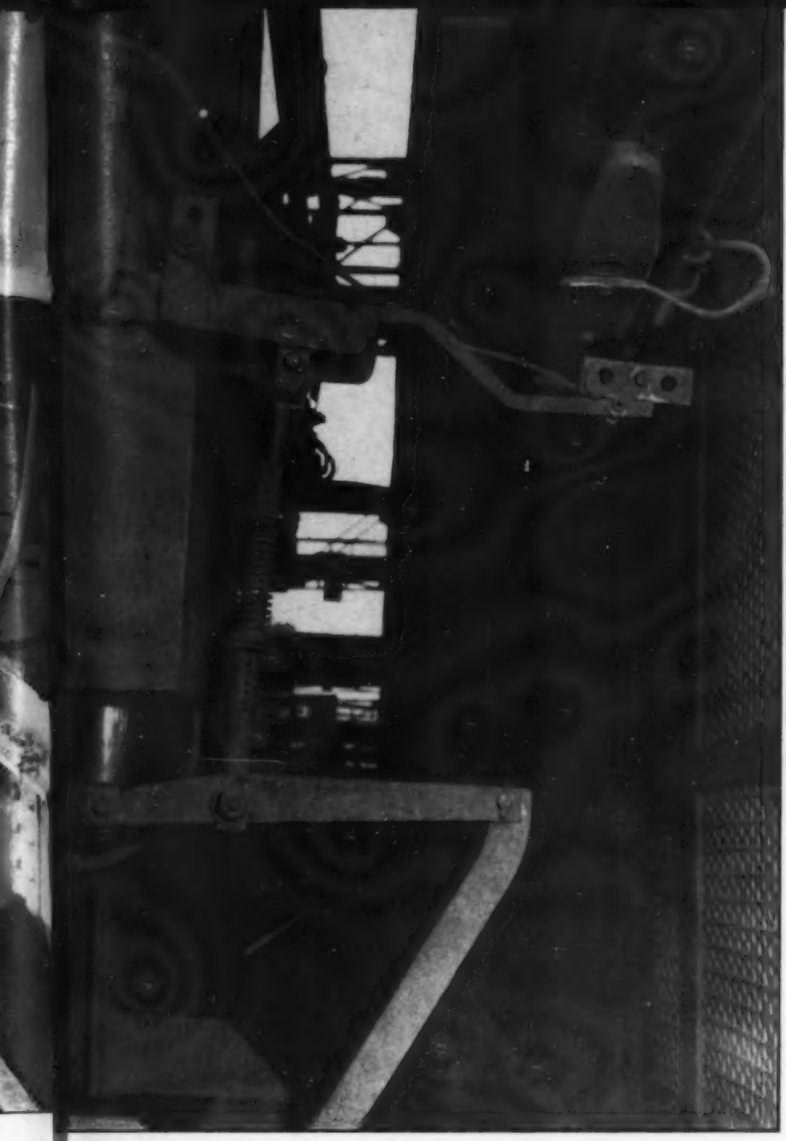


Figure 3 — The replacement of a motor, used for closing contacts on coke pushing equipment, by a solenoid reduced maintenance on this equipment.

cotter pins, changing the cable from the worn to the new shoe, slipping the new shoe into place and replacing the cotter pins. The materials used in constructing this rigging are nearly always available and the only machine work required is drilling.

Insulating outdoor power rails is a problem that sometimes presents serious difficulties, particularly when the rails are side contacting. Those referred to above are standard 40 lb rails supported with the base in a vertical plane. The supports originally installed are standard, 3 inch porcelain insulators bolted to angle iron uprights. A piece of steel with a hook bent on the bottom end and a clamp at the top forms the rail support. The clamp is made with a shoulder and is so spaced and shaped that the rail base is not held rigidly but is free to move. We found that this freedom for motion existed only for a short time after the rails were installed. Ore and flue dust worked its way into the openings. Rain came along and packed it in. Expansion or contraction of the long stretch of power rail made it creep, or attempt to creep, at each insulator. The clean insulators allowed this crcepage but dirty and partially corroded ones did not. Since a comparatively small shearing moment will crack porcelain that is already under tension, this resulted in many broken insulators. The breaking of one insulator often added just enough strain on the ones adjacent to cause them to break also. On one lovely afternoon, we had a stretch of approximately 100 feet of power rail down. This problem might have been solved by frequent cleaning at each rail support, but this would have been an endless task. The transfer car power rail is about ¾ of a mile long with supports approximately every six feet, giving a total of some 1100 insulators. We decided to try replacing the two insulators on each upright with a single wooden block. Finished maple about 3 inches square was cut into blocks about 12 inches long. The blocks were put into a tank of melted paraffin and allowed to remain until they sank. Holes were then drilled to match the inserts in the original porcelains and counter bored so that all bolt heads would be imbedded in the wood. The original rail supports were assembled on the blocks and the counterbores filled with sealing compound.

We have found that the blocks are a decided improvement in our installation. The paraffin filled maple is a good insulator. It has plenty of strength to support the rails and is resilient enough to withstand ordinary strains imposed by rail expansion. Its biggest advantage lies in the fact that it is also tough and fibrous enough to hold the power rail in place even if badly split. About half of the original porcelain insulators are still in service. They are replaced with the wooden block type whenever necessary. One disadvantage should be mentioned. The flat block furnishes a backing for ore, coke breeze and other dirt to build up between the two power rails. In wet weather this small pile of dirt sometimes becomes a fairly good conductor of electricity allowing enough current to leak across between the rails to char the wood. Occasionally the wood ignites but usually the pile of dirt disintegrates before this occurs. The charred portion of wood can then be scraped away and coated with insulating varnish, leaving the insulator almost as good as new.

Usually it is found that the more simple a device, the less troublesome it is to maintain. If a solenoid can be made to accomplish the same results as a motor, the maintenance department prefers the solenoid. A special application of a solenoid operating a movable contact through a system of levers is now used to complete an interlock circuit on our coke pushing equipment. This interlock circuit withholds control of the pusher ram from the operator until it is completed. One of its contacts is closed through a movable shoe which raises up to make contact with a stationary plate. A heavy cast iron shoe somewhat similar to the main power collector shoes was originally utilized. It was raised by hydraulic pressure supplied by a small 250 volt direct current motor driving a pump. The motor soon began to require excessive maintenance, due mostly to a very dirty operating condition which is unavoidable. In making a study of this problem with the idea of possibly using a solenoid operated mechanism, several conditions were noted. An excellent pusher track foundation made it unlikely that the vertical distance between the rail and the series of stationary contact plates would ever vary excessively. The elevation of any plate could be easily adjusted by simply inserting or removing flat washers.

(*Please turn to page 85*)

Maintenance of Diesel Switching Locomotives

. . . . observational records on the behavior and maintenance of diesel locomotives provide the basis for an analytical approach to the maintenance program . . . .

By R. W. VAN SANT, JR.
Industrial Lubrication Engineer
Gulf Oil Corporation
Pittsburgh, Pennsylvania

▲ IN 1924, 22 years ago, the first diesel engine made its appearance in railway service as a switching locomotive. The growth of the diesel in this field has been rapid, as it was in the 27 years preceding the adaption of this engine to railway service. In 1892 the compression ignition engine was patented in Germany by Dr. Rudolph Diesel. Five years later, the first combustion stroke of the experimental model ended in an explosion that destroyed the engine. It is characteristic of the rapid developments that have been made that a successful diesel engine was exhibited during that same year, 1897. In 1898 Adolphus Busch of St. Louis bought the American manufacturing license for the diesel engine and formed the Diesel Motor Company of America.

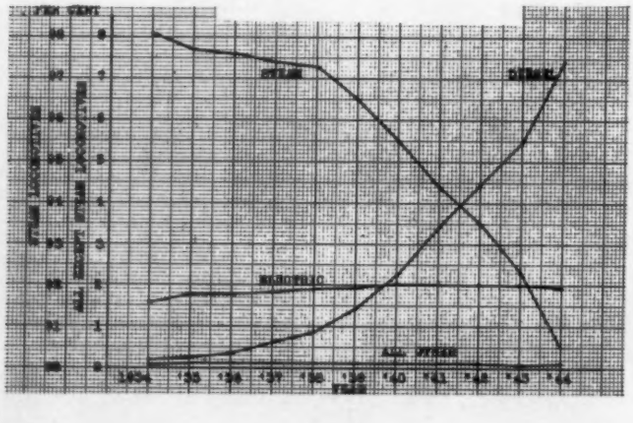
Naturally, stationary applications were the first commercial uses of the diesel engine. However, in 1910 the first diesel engine was installed in an ocean-going vessel at Amsterdam and the first successful automotive application was made in Germany in 1922. At the beginning of World War I there were only a half dozen well known manufacturers who produced diesel engines for industry. That war brought about expansions in manufacturing facilities for diesel equipment and improvements in design that produced a more rapid progress in the growth of the diesel industry.

The ability of the diesel engine in switching service had been well established from its introduction in 1924 to 1933, at which time it became firmly established in the passenger locomotive field. The striking performance made in 1933 by a non-stop passenger train run from Chicago to Denver, at an average speed of 83.69 mph, drew the attention of railroad operators and the public alike.

At the beginning of World War II, approximately 15 million diesel horsepower had been manufactured in the United States. However, in the year 1944 the estimated diesel horsepower manufactured by the industry was approximately 35 million. It is evident that the production in 1944 was high because of the great acceptance of the diesel engine in naval service. Nevertheless, one manufacturer of locomotive diesel engines is today producing this equipment at the rate of 5 million horsepower per year. This production alone is equal to one-third of the diesel horsepower manufactured in the U. S. up to 1939.

The graph of Figure 1, "Locomotive Units Operated on all U. S. Steam Railways, Type of Power by Per Cent," is based on figures published by the Interstate Commerce Commission in their 1946 report of "Statistics of Railways in the United States." This graph indicates the trend of diesel applications in all types of railway service. It will be noted that the rapid expansion of diesel service began in 1935. At that time it represented approximately 0.27 per cent of the total number of locomotive units operated, whereas steam

Figure 1 — Locomotive units operated on all U. S. steam railways, type of power by per cent.



Presented before AISE, Detroit District Section Meeting, November 12, 1946

power represented approximately 97.7 per cent. The rapid decline in steam locomotives began in 1938 when they represented approximately 97.3 per cent of the units in service. The diesel locomotive units in service then represented approximately 0.85 per cent. This rapid growth of the diesel engine, in railway service, continued through the war years despite the heavy requirements of these engines by the armed services. By 1944 they represented approximately 7.4 per cent of the railway locomotive units in use. The steam units in service had declined to approximately 90.5 per cent of the total. The electric locomotive gained only a fraction of a per cent of the total locomotive units operated by the railways from 1934 to 1944, 1.57 to 1.95 per cent, respectively. All other types of locomotives including gasoline, gas-electric, storage battery, and diesels with mechanical transmissions, operated during the period from 1934 to 1944, remained practically constant at 0.1 per cent of the total units operated. In reviewing these facts, it is necessary to bear in mind that many industrial switching and other switching operations are omitted. Therefore, it may be assumed that the per cent of diesel electric locomotive units operated on all railway service applications in the United States will be considerably higher than indicated by this graph.

Economy in service is the over-all reason for the rapid growth of the diesel engine in both switching and main line service. However, the individual factors which make up the over-all measurement of economy may differ for the specific railway service of the diesel locomotive, as compared with the steam locomotive. Availability is another of the over-all factors that make the diesel locomotive highly desirable, since its availability may be 95 per cent in switching service which is considerably higher than that normally attained for steam locomotives operating in the same capacity. Economy in fuel is another attribute of the diesel locomotive, which has the highest thermal efficiency of any commercial prime mover. Claims of over 30 per cent for over-all efficiency have been made for diesel locomotives which compares very favorably with efficiencies of 5 to 8 per cent for the steam locomotive. In addition to the conservative estimate of a savings of $1.00 to $1.50 per operating hour for the diesel as compared with the steam locomotive, the flexibility of the diesel engine and its capacity make it highly desirable as a switching locomotive.

Steel mill switching imposes conditions that are unlike those encountered in other diesel engine switching service. This is particularly true of the nature of the intake air, due to the high content of foreign material. This foreign material may be drawn into the engine in spite of good air filter maintenance practice. Figure 2 shows two valves from a 1000 horsepower diesel switching locomotive. Due to wartime emergencies, this engine operated in and around steel mills for 32,192 hours without valve maintenance. These badly worn valves were typical of the intake valves from this engine. Blow-by, which resulted from warping, caused the lacquer deposit on one valve. The battered condition of the other valve resulted from the type of material used in this particular valve. The most interesting feature is the heavy deposit on the back of the valves and on the valve stems. An analysis of this deposit indicates a considerable amount of foreign material: 2.63 per cent

Figure 2 — Intake valves of steel mill diesel locomotive have been badly worn by 32,192 hours of service.

silica; 4.34 per cent ferric oxide; and 1.50 per cent aluminum oxide. These materials unquestionably originated from dirt, sand, iron ore, and clay which were drawn into the engine through the intake air system. The remainder of this deposit is soot and oil.

Of course the majority of the foreign materials that pass through the air filter continue on through the combustion space and out the exhaust stack. However, some of these materials deposit on the piston and rings. Figure 3 shows deposits that are typical for this engine after 32,192 hours' service. The accumulation of soot and lacquer has combined with the foreign material from the intake air to form a heavy deposit. This deposit stuck the second compression ring for an angle of approximately 180 degrees and was indicated by the lacquer visible on the face of the ring. The remaining 180 degree segment of this ring was pinched in the groove, but was not stuck. This was proved by the lack of lacquer on the face of the ring, which indicated that it was active in operation and was only pinched or cold stuck for this remaining angle. The number 3 compression ring was pinched for approximately 180 degrees. The number 4 compression ring was pinched for 315 degrees and stuck for 45 degrees. Compression ring number 5 was found to be quite sluggish and approximately one-half inch had been broken from one end. The number 1 and number 3 oil rings were sluggish, but all of their oil slots were open and none of the piston drains under number 1 oil ring were completely plugged. Number 2 oil ring was pinched for 90 degrees and a few of its slots were plugged. An analysis of the deposit scrapped from this piston indicated that 1.31 per cent was ferric oxide and only 0.01 per cent was silica or dirt. The remainder of the deposit was soot and oil.

Some foreign material from the atmosphere penetrated further into this engine. It may have entered with compression ring blow-by, or washed from the pistons by the lubricating oil, or entered the crankcase through leaky gaskets and breathers. This material then circulated with the lubricating oil and was either removed by the filter or settled at a point where oil flow and turbulance were low. Figure 4 shows the further penetration of foreign material and other matter into the engine system by a deposit on the walls of the push rod gallery above the camshaft. An analysis of

this deposit indicated a further reduction in foreign material: by weight, 0.04 per cent silica; 0.31 per cent ferric oxide; soot and oil constituting the remainder of the deposit.

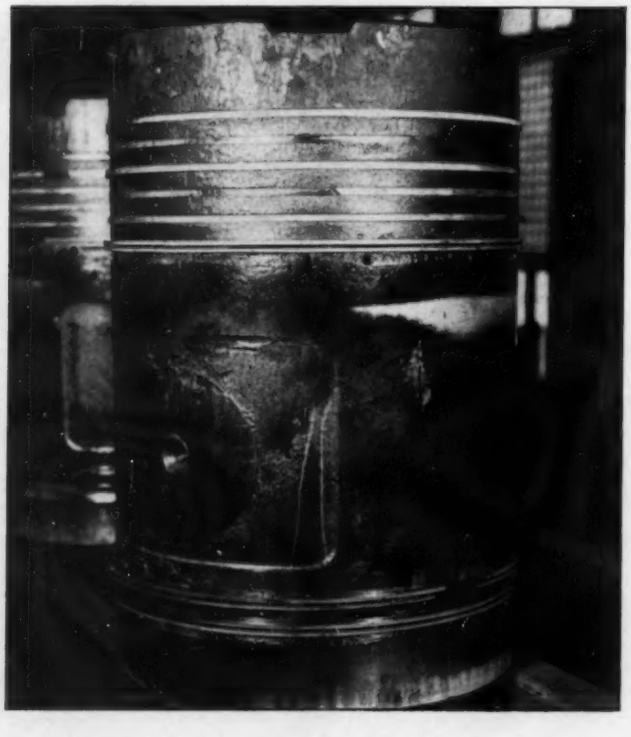
The bearing surfaces of this engine showed considerable scratching due to the presence of foreign material in the lubricating oil. This foreign matter no doubt contributes to an increase in the wear rate experienced in engine parts operated in this service. In this particular engine, the cylinder liner diametrical wear rate over the 32,192 hours of service was 0.0012 inches per 1000 hours operation. This was high in comparison to some of the same engines operated in similar service but in cleaner atmospheres.

Maintenance of the diesel locomotive, like other equipment, must be such that it strikes an economic balance between maintenance and repair. Also, it should provide protection of the life of this equipment, since a 1000 horsepower diesel locomotive usually represents an investment of approximately $90,000. The manufacturers of diesel locomotives generally specify maintenance procedures that their experience indicates will be satisfactory to attain a reasonable balance of maintenance and repair and to provide protection for this investment. However, many factors depending upon the individual characteristics of the service and maintenance procedures cannot be evaluated until actual operating experience under these conditions has been accumulated. Then, too, there are unusual demands brought about by such periods as the recent war years that require the maximum use of equipment with the minimum down-time. This results in immediate high availability at a sacrifice to future requirements.

Figure 5 indicates the sacrifice that is made in delaying maintenance to obtain immediate high availability during a period of extreme demands, caused by wartime operation. Five of the first six of these 1000 horsepower engines, representing service life periods from 3294 to 14,709 hours, had accumulative lubricating oil consumption rates less than 0.06 gallons per hour and ranged from 0.045 to 0.059 respectively. Engine number 4 is the exception to this case, since it had a lubrication oil consumption rate of 0.086 gallons per hour after an accumulated service period of 6790 hours. However, this engine had been operated under heavier loads than any of the remaining ten engines shown on this graph. This was indicated by its fuel oil consumption rate, which was 43 per cent higher than that for the average of the other engines. Engines number 7 through number 11 represent a change in service hours from 19,497 to 21,706 with a respective change in lubricating oil consumption from 0.065 to 0.087 gallons per hour. These eleven engines were operated on the same maintenance schedule, which included changing the oil after each 4000 hours service, checking the valve tappet clearances every thirty days, and testing the injectors every three months, along with other normal maintenance. This schedule did not include maintenance of the valves, cylinder liners, bearings, pistons and piston rings during this period. Therefore, it is evident that under these conditions of operation a sacrifice in oil economy was made. In addition, this procedure resulted in a subsequent decrease of actual availability.

Besides the effect of the foreign material caused by atmospheric polution in steel mills, the heavy and shock loads of steel mill switching make it one of the most critical tests of diesel locomotive equipment. The precautions that can be taken in this switching service are: first, in the selection of equipment for this heavy duty service; second, the maintenance of the equipment to protect the original investment.

Figure 3 — Heavy deposits may form on the pistons and rings in steel mill service.



The first step in establishing and maintaining an efficient diesel locomotive maintenance program lies in the selection of well qualified maintenance personnel. Fortunately, the expanded use of the diesel engine now makes it possible to readily secure personnel for maintenance work who are reasonably familiar with the quality of workmanship required. There are various means of improving the training of the maintenance personnel. Several engine manufacturers have offered training courses which are of considerable assistance in forming a nucleus of trained personnel within a maintenance organization. To supplement the training of maintenance personnel, some railroads have organized a diesel course which is operated from a car equipped with various makes of injectors and other equipment. This car is transported to their various shops for additional periodic training of their maintenance men. The opportunity to visit other shops maintaining diesel locomotives offers an excellent opportunity to improve the maintenance technique by observation and exchange of ideas.

The second highly important element of efficient maintenance lies in making provisions for convenient maintenance and repair equipment. This should include a building of the proper size for the number of units being operated with reasonable allowances for the operation of additional locomotive units, should they be purchased at a later date. To obtain high quality workmanship it is certainly advisable to have clean and light

surroundings and the building should be designed with these features in mind. Of course, the selection of the maintenance equipment must be based on the economics of this requirement. That is, a large operation may have the shop arranged to service particular features of the different makes of locomotives, whereas the smaller operation should have the shop arranged to service the features that are in common with the several makes of engines that are operated. Simple features are important such as platforms at a convenient level for engine maintenance, and cranes arranged for convenient handling of cylinder heads, pistons, connecting rods, and other heavy pieces of equipment. Many special tools may be made to assist in pulling cylinder liners or performing other maintenance or repair operations. These savings are reflected in the efficient use of high quality maintenance time by shortening the hours required to do a particular job, and improving the quality of the maintenance work by avoiding damage that may occur in such operations as pulling a cylinder liner or removing a piston and connecting rod with awkward equipment. These savings are also reflected in locomotive availability and in over-all switching costs.

The third important feature of a well organized maintenance practice lies in developing a convenient schedule for all diesel locomotive maintenance work that may be readily followed. Therefore, the best starting point is with the maintenance schedule recommended by the locomotive manufacturer. Many of these schedules are quite complete and easily cover the requirements that produce satisfactory availability with low repair costs. The service personnel of these manufacturers are usually well qualified to suggest modifications of these maintenance schedules to meet particular requirements of a maintenance program. However, the occasion often arises which prevents following such a schedule and such recommendations completely. This may be the result of excessive switching demands made on the equipment, or modifications made to increase the frequency of certain maintenance operations to compensate for unusual conditions due to the locality, or in some instances, in an effort to reduce maintenance cost figures. Naturally, in making modifications in such a schedule the normal procedure is to analyze availability and costs. In many cases, availability may be somewhat misleading since it does not necessarily insure good mechanical condition, fuel economy and lubricating oil economy. Nor does availability immediately reflect damage to some of the mechanical equipment due to worn parts or the possibilities of breaking a crankshaft as a result of excessive crankshaft deflections. Unfortunately, maintenance costs records do not reflect the mechanical condition since they provide no means of determining how much is being borrowed from the future life of the engine to reduce today's cost figures. Therefore, maintenance costs and availability fail to provide the detail information required to measure the efficiency of a maintenance program and must be supplemented with accurate mechanical data.

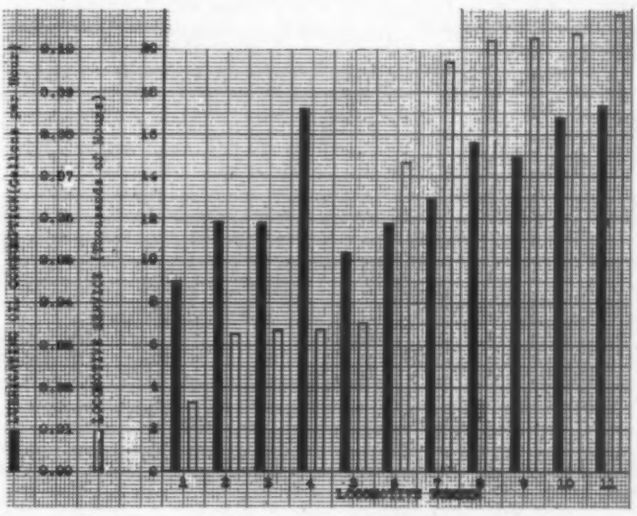
The mechanical data should include complete performance records. This is essential if an analysis is to be made in order to determine the efficiency of a maintenance program. Some operators keep very good mechanical records including replacements of all parts, and wear data accumulated on rings, cylinder liners and

Figure 4 — This photograph illustrates the deposits in the push rod gallery.

bearings in order to more closely control their maintenance of these and other engine parts. However, this data can be accumulated only after considerable time, and in all instances cannot be used to improve these conditions prior to the occurrence of considerable wear or other indications of trouble. Therefore procedures established to determine compression pressures, firing pressures, injector condition, and crankshaft deflections are more helpful in controlling maintenance before excessive wear of the parts or decreased performance of the engine reflect the trouble. In addition to this data an inspection of the engine condition analyzing the location and reasons for the deposits within the engine can be quite helpful in determining the operating difficulty. Since deposits usually occur early in a trouble cycle, corrections made on this analysis may forestall damage and restore good operation.

Figure 6 provides one method of analysis which may be used in this manner. This chart is quite general and may be modified to fit the design characteristics of the particular engine involved. Most operators of diesel locomotives use a measurement of this kind, based on their memory of previous observations, but few make records that may be compared from time to time. The

Figure 5 — The locomotives with the high oil consumption rates are, in general, the ones with the longest periods between complete maintenance overhauls.



ENGINE CONDITION

Locomotive No. _____ Locomotive Make _____ Type of Service _____ Where Operated _____ Hours Since Last Report _____ Total Hours _____	Nature	Quantity: Excessive / Heavy / Medium / Light / None	Removal*: Difficult / Easy	Report is Accumulative for all Cylinders _____ Report is for Cylinder No. ____ Remarks	Rating**
Rocker Arm Assembly Deposits					
Crankcase Deposits					
Cylinder Liner Port Deposits					
Air Box Deposits					
Piston Deposits					
Crown					
Lands					
Skirt					
Valve Stems					
Bearings					
Connecting Rod					
Lacquer Deposits			___ ___		
Corrosion			___ ___		
Main					
Lacquer Deposits			___ ___		
Corrosion			___ ___		

Rings - Number Stuck ____	Valve Seating Satisfactory_____ Unsatisfactory_____	Injectors (If tested) Satisfactory_____ Unsatisfactory_____

* Removal by wiping with a dry clean lint-free cloth to reveal original surface.
** Comparative with other engines operated under similar service, expressed in per cent.

Reported by _____

Date _____

Figure 6 — One suggested record which can be used to study effectiveness of engine maintenance program.

rocker arm assembly frequently presents an excellent opportunity for the accumulation of deposits. Combustion soot, dirt taken into the crankcase through breathers or leaky gaskets, and partially burned hydro-carbons from the lubricating oil settle on the surface under the rocker arm assembly, because this is an area of low lubricating oil flow rate and turbulance. Certain locations in the crankcase also may provide conditions that promote a rapid rate of deposit accumulation. If definite records of these conditions are maintained, any upward trend will be noted and this may be analyzed and the trouble corrected. This can be accomplished by the improvement of combustion conditions, if this is a source of difficulty, or by an increased frequency in lubricating oil filter change practice, if the deposits cannot be kept out of the lubricating oil system. Two cycle intake porting engines present the opportunity of making an even closer observation of combustion conditions than do four cycle engines; since the piston deposits can be noted without engine disassembly. Increased deposits in this area may result from faulty injector operation that can be corrected. On the other hand, combustion difficulty due to rapid load changes which may run as high as 1.5 changes per minute per 24 hour day, may be improved somewhat by the selection of the fuel.

These same observations may be made at both the regular inspection periods and at the time of disassembly for major maintenance operations. They may be accumulated observations for all cylinders or for individual cylinders, or for certain cylinders selected on the basis of knowledge of particular characteristics of that engine. These observations may be made more complete when the engine is disassembled for periodic maintenance and inspection work by including data covering corrosion of main and connecting rod bearings and lacquer deposits on valve stems and bearings. Of course this record serves only as an indicator, but data accumulated on this basis presents the opportunity of making modifications of maintenance in advance of the time at which such decisions can be reached on the basis of actual repairs and measurements of mechanical wear.

Certainly there are many problems in the maintenance of diesel switching locomotives that cannot be readily answered and future design may impose more perplexing maintenance problems. Therefore, the only solution to these problems lies in an analytical approach based on records of observations that can be made prior to the occurrence of excessive wear and mechanical failure.

CHEMICAL REMOVAL OF

Scale, Sludges and Oxides

FROM STEEL PLANT EQUIPMENT

. . . . the chemical process for removing scale is finding increasing application in the various departments of the steel plant . . . . this development is the result of the use of proper inhibitors . . . .

By B. H. McDANIEL
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Dowell, Inc.
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▲ THE iron and steel industry for many years has employed the use of acid and other chemicals for the purpose of removing surface scales. The pickling process is employed both to remove oxide scale and to protect the product against corrosion. Chemical solvents also have been used for the removal of calcareous scales, sludges and oxides formed in equipment during its operation. However, the results have been varied and occasionally unsatisfactory, due in part to incomplete information concerning the materials which are used, and lack of adequate equipment for their control.

During the past five years, the use of chemical solvents for the removal of scale and sludge deposits in heavy industrial equipment has been greatly increased. Probably the most important reason for this increase has been the development of more effective inhibitors which allow the use of chemical solvents at elevated temperatures.

The mechanism of inhibition has been the subject of considerable discussion by chemists for many years, and today is still largely a matter of conjecture. Particularly in large industrial installations, the proper use and thorough knowledge of inhibitors is vital. This fact has been pointed out only recently by Powell and need not be elaborated further here. But, we may say that inhibitors now are available which will protect mild steel and most of the metals normally used in the manufacturing of heat exchange equipment, up to a temperature of 165 F in a chemical cleaning operation. As elevated temperatures are essential for effective solvent removal of many scale compositions, the use of proper inhibitors becomes imperative.

The effect of inhibited hydrochloric acid compared with that of uninhibited acid is shown in Figure 1. The tests were made with sandblasted, mild steel and 15 per cent hydrochloric acid solutions over a temperature range of from 75 to 175 F. The results are reported in lb of metal loss per sq ft per day, or 24 hour contact period. It will be noted that the rate of corrosion loss of the uninhibited acid materially increases from 95 F and actually goes off the chart at approximately 172 F, while inhibited acid has a steady increase, with a loss of about 0.04 lb per sq ft per day at 175 F. With such protection for metals, hydrochloric acid, along with its many possible additive agents, has proved to be a very capable solvent for the removal of most scale compositions existing in heat exchange equipment.

Also to be considered as contributing to the advance of solvent cleaning is the present knowledge of wetting agents, catalysts and intensifiers which may be employed for the purpose of altering the characteristics of the basic solvent. Additive agents are used to increase the solubility of many complex scales as well as to speed-up the reaction rate of the solvent. In this manner, even scales containing high percentages of silicates are readily dissolved by hydrochloric acid base solvents. Additive agents for accomplishing many other purposes also may be used with distinct advantages.

Industry long has recognized the possibilities and advantages of chemical solvent cleaning. Due to the highly specialized nature of most cleaning operations, however, the actual development of techniques and the commercial application of those techniques were not well suited to producing industry. Extensive laboratory facilities and intimate knowledge of scale formations was required, as well as a wide range of available solvents, heavy equipment for their proper use, and skilled technicians to carry on the job. This field, then, was one particularly suited to service company development. Producing industry's willingness to cooperate with these companies and its continued interest in their service is unquestionably the dominant factor responsible for the present stage of development of chemical scale removal service.

Presented before AISE Annual Convention, Cleveland, Ohio, October 4, 1946

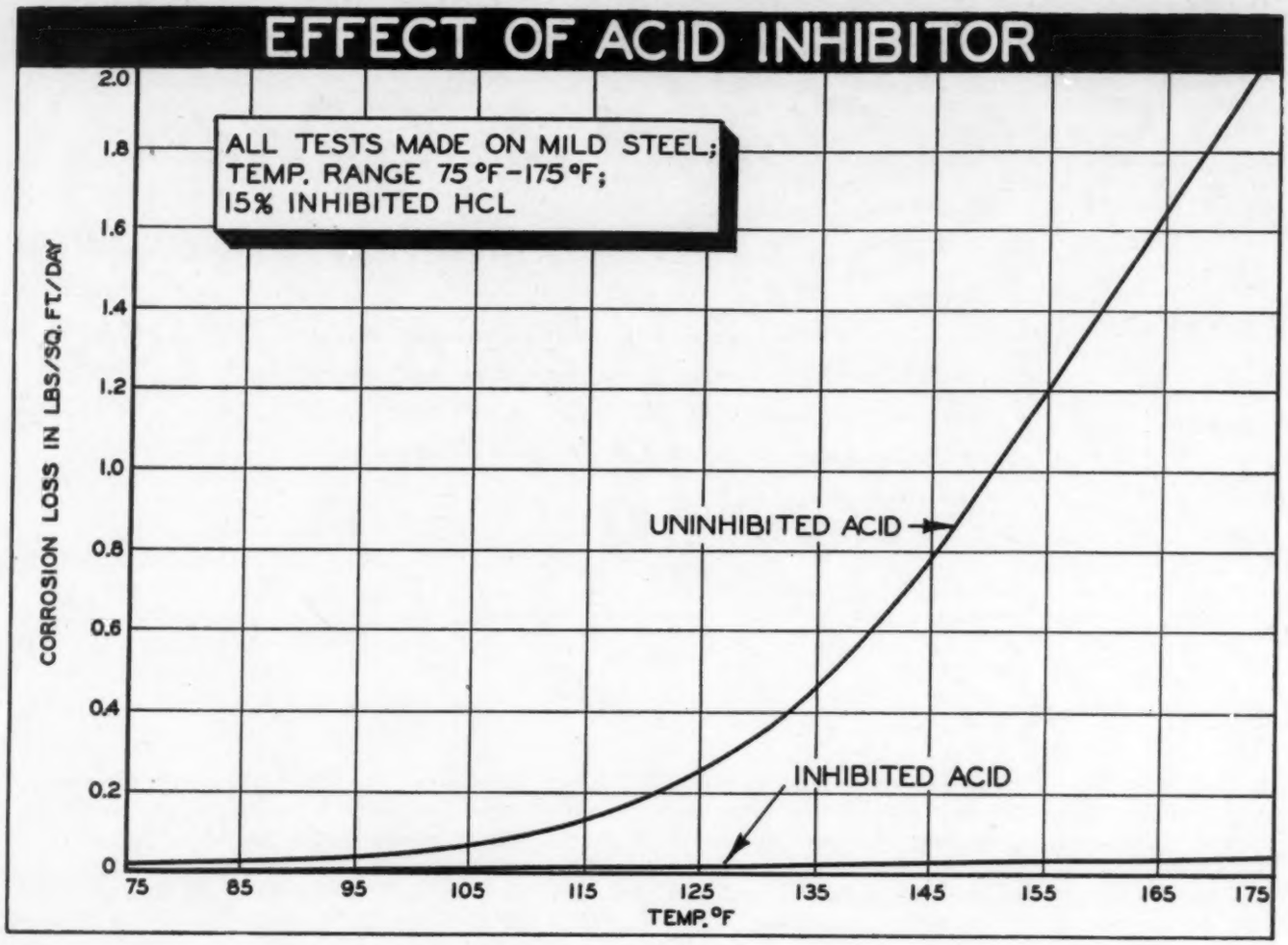

Figure 1 — As shown by the curves, inhibitors reduce corrosion loss to a small quantity.

BLAST FURNACE CLEANING

One of the most beneficial uses of chemical solvents has been in the removal of deposits from the cooling systems of blast furnaces. As the amount of water required for proper cooling of a blast furnace is tremendous, the water usually is taken from the nearest available source. This water may or may not be desirable with reference to hardness and corrosive properties. Also, due to the quantity involved, it is expensive to condition the water, an expense considered by many to be excessive and impractical. As a result the cooling water often is used in its original state and accumulations are deposited on the surfaces of the entire system. These deposits reduce the cooling capacity of the system, causing a chronic maintenance problem.

The scale and sludge deposits ordinarily found in blast furnace cooling systems consist mainly of iron oxides, silicates, mud or clay, organic material, copper salts, and in some areas, calcium carbonate. The constituent percentage of the scale will vary with the water conditions, the rate of flow and the rate of heat exchange. The quantity of the scale deposit is also dependent on these factors. In this connection it is often noticeable that the warmer parts of the cooling system, such as the hearth and bosh, will be scaled more heavily.

In anticipation of a solvent cleaning operation, samples of the scale involved should be obtained and studied by a competent chemist. The deposit first should be examined for its physical characteristics, such as density, porosity, thickness and manner of formation. Following this general examination, the chemical compounds composing the scale may be identified by either chemical, X-ray or spectroscopic analysis. Through the use of the X-ray and other modern laboratory methods, as described by Alquist, Groom and Williams, more than 80 different compounds have been identified in water deposited scales which are present in heat exchange equipment. Among the more common of these compounds are the ones shown in Table I.

After considering the physical and chemical characteristics of the scale, solubility determinations are made using the indicated solvents of varying strength and proportions, duplicating as nearly as possible the conditions which will be encountered in the actual operation. These tests not only verify the choice of the solvent but indicate the best treating technique and the necessary contact time that will be required for removal of the scale. From the results of the laboratory study of the scale deposit, and considering the structural design of the unit in question, a suitable procedure and treating technique may be determined. This technique is, of course, flexible and may be subject to change by unforeseen developments which may arise during the treatment.

TABLE I

Compounds Found in Scale

Calcium carbonate	$CaCO_3$
Calcium Sulfate	$CaSO_4$
Calcium hydroxy phosphate	$Ca_{10}(OH)_2(PO_4)_6$
Magnesium hydroxide	$Mg(OH)_2$
Magnesium silicate	$Mg_3Si_2O_7 \cdot 2H_2O$
Silica	SiO_2
Ferrous Oxide	FeO
Ferric Oxide	Fe_2O_3
Ferrous Ferric Oxide	Fe_3O_4
Ferrous Sulfide	FeS
Ferrous cupric sulfide	Cu_3FeS_3
Sodium aluminum silicate	$NaAlSi_2O_6 \cdot H_2O$
Pectolite	$4CaO \cdot Na_2O \cdot 6SiO_2 \cdot H_2O$
Noselite	$Na_8Al_6Si_6O_{24} \cdot SO_4$

Blast furnace cooling systems may be cleaned chemically either while the furnace is in service, banked or cold (see Figure 2). As it is not often that a furnace is removed from service and allowed to cool down, we shall consider solvent cleaning with the furnace in operation.

The general technique employed is to use the solvent as the cooling medium, and at the same time obtain heat from the furnace walls to speed up the reaction of the solvent. This means that the contact period of the solvent with the scale will be governed by the temperature rise of the solvent. Since temperatures above 165 F may not be used safely with the presently available inhibitors, caution must be taken to displace the solvent from the system before its temperature exceeds this figure. Also, since the solvent is being used as a cooling medium, care should be taken not to stop circulation in any one part of the system for too long a period as over-heating of the cooling blocks may occur.

The time that the solvent may be allowed to soak or remain static in separate cooling cycles of the furnace system will vary widely. Experience has shown that in separate sections of the furnace, such as the hearth and bosh cooling coils, the temperature rise is more or less constant with reference to time. In the bosh system, the soaking period of the solvent is seldom longer than 5 minutes, while from 30 to 35 minute periods may be necessary on the upper stack. It is a customary practice to predetermine the approximate time the solvent safely may soak in each section of the furnace by making preliminary tests with water and recording the temperature changes.

The method now employed for cleaning a furnace cooling system is to isolate the separate cooling cycles or feeds from the overall system and treat each cycle independently. The treatment consists of alternate stages of solvent, with water washing and air blowing between stages. This is repeated as often as is required, or until increased flow rates and the drop in solvent concentration is sufficient to indicate that scale restrictions have been removed.

Furnaces which are equipped with both high and low pressure water supplies, and an arrangement of valves so that either source may be used, are ideal for solvent cleaning. One or the other supply line can be tapped and used as a solvent input line. Then, with proper valve control, the circulation of either solvent or cooling water may be obtained as desired.

When only one source of water is available, a solvent supply line must be furnished to a control location on the operating floor. From this point, flexible hose may be used to connect the solvent line to the separate cooling feeds. This connection ordinarily is made at the opening which normally is reserved for air and steam blowing. When air blowing is required during the treatment, the solvent hose must be removed and the air hose attached.

The objective of the cleaning procedure is to allow the solvent to remain in contact with the scale deposits for sufficient time to insure their dissolving or disintegrating, in order that they may be flushed from the system. Since the time the solvent can remain in the system is controlled largely by the temperature rise, repeated filling of the system with solvent is required. Considering the fact that the solvent will have to be circulated from the system following a limited period of contact, thought must be given to the concentration of the solvent as introduced, in order that maximum work can be obtained from the solvent during its limited contact period. It is desirable to select a concentration of the solvent that will give: (1) the fastest reaction rate; (2) the maximum use of the solvent as determined by its loss in concentration.

A limited number of feeds may be considered for cleaning simultaneously, or as a continuous process, but usually they are handled as independent cycles. The number which can be handled at any one time is dependent on the condition of the piping and the number of outlets that can be conveniently controlled. In systems where corrosion is active and the scale deposits are actually sealing thread joints, the removal of the deposits will establish leaks. As each feed system can

Figure 2 — Blast furnace cooling systems may be chemically cleaned during any stage of operations.

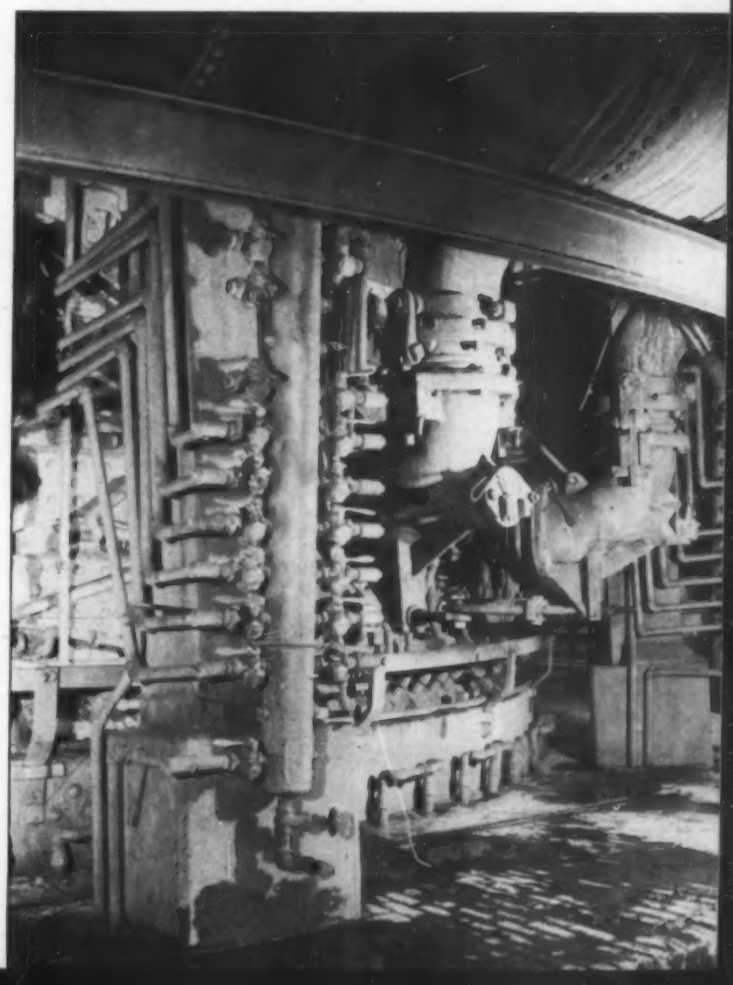

Figure 3 — Hearth cooler after cleaning.

be without water cooling only a short time, the leaks have to be repaired immediately. Therefore, caution should be taken not to establish more leaks than can be readily repaired. Also it should be remembered that maintenance work above the operating floor level on a furnace often requires the use of gas masks by the men as protection from noxious gases. This condition can materially increase the time which is needed for repairs. Considering these points, it has been established that from 3 to 6 feeds is the maximum number which can be conveniently controlled and treated simultaneously.

In order better to evaluate chemical cleaning for the removal of scales from furnace cooling systems, we shall consider the following case histories.

In the spring of 1946, the cooling system of a large furnace, rated at 432,000 tons, was chemically cleaned. The job consisted of descaling the bosh, mantle and stack, tuyeres, cooling blocks and the associated piping. A total of 11,475 gallons of solvents were used and the work completed in 94 hours, or eleven working days. Comparative flow tests were made and reported as follows:

Before cleaning the bosh cooling system circulated water at a rate of 3,303,360 gallons per day. After cleaning the bosh cooling system circulated water at a rate of 4,536,000 gallons per day. This was an increase of 1,232,640 gallons per day, or 37.3 per cent. Sixty days following the scale removal treatment, the bosh system was still circulating water at the rate of 4,147,200 gallons per day, an increase over the original flow rate of 22.5 per cent.

Before cleaning the stack cooling system, water could be circulated at a rate of 614,880 gallons per day. After cleaning water could be circulated at a rate of 887,040 gallons per day. This was an increase of 172,160 gallons per day, or 28 per cent. Sixty days after cleaning, water was circulated at a rate of 743,040 gallons per day, 20.8 per cent over the original flow rate.

Following the cleaning, there was no noticeable change in the temperature of water discharged from the system, so the increase in water flow also is a measure of the increased cooling effectiveness of the system.

This same cooling system had been chemically cleaned during the year 1945, with the exception that the hearth unit was included and the tuyere cooling blocks omitted in the operation. On this job the furnace was down for repair, and, as the installation was cold, the cleaning procedure varied somewhat from that previously described. The solvent was heated prior to its introduction to the system, and, in some sections, re-circulated in order to maintain the desired treating temperature. This cleaning operation required the use of 13,400 gallons of chemical solvents, and the work was completed in 50 hours time. An inspection following the job indicated that 85 to 90 per cent of the scale had been removed.

Another cleaning job consisted of the hearth jackets system only of a furnace rated at 198,950 tons. The furnace had been out of service for some time and the jackets were cold. A total of 1500 gallons of solvent was circulated through the system, until an average temperature of 120 F was obtained on the solvent returns. After this temperature was obtained, the solvent was allowed to remain in the system for two hours. Following the job, comparative flow tests indicated a 50 to 60 per cent flow increase. Several water pipes then were removed for inspection and found to be entirely free of scale. Here, the entire operation was completed in eighteen hours.

Chemical cleaning of blast furnace cooling systems should result in:

1. Longer life for the cooling system and furnace walls.
2. Reduction of maintenance costs of the system during its economic life.

Figures 3, 4, and 5 show the condition typical of blast furnace equipment which has been chemically cleaned. Figure 3 shows a cross section of a hearth cooler, its tubes metal-clean. Figure 4 shows the hearth cooler inlet and outlet ports, the tubes completely free of scale. Figure 5 shows a section of the bosh plate, metal-clean. Results such as these are considered normal for a properly handled chemical application.

Three separate effects are obtained through the use of chemicals in scale removal. First, the chemicals remove the scale formation, which in itself will restore the heat transfer efficiency of the unit. Second, following removal of the scale deposits, any active corrosion which may exist will tend to be retarded. Third, following the scale removal, the increased flow and cooling

Figure 4 — The tubes of this hearth cooler inlet and outlet ports are completely free from scale.

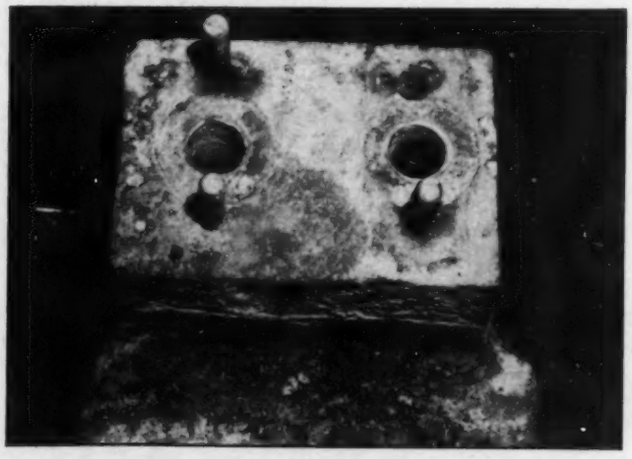

Figure 5 — Bosh plate after cleaning.

exchange rates will tend to reduce excessive scale deposition.

The foregoing poses the question, "How often should a cooling system be cleaned?" The answer, of course, varies with local conditions. The proper cleaning time is something that should be determined by the operators, if they are to receive the full advantages. We already have discussed chemical cleaning as a method of reducing maintenance costs and increasing the economic life of a furnace. But, in order for this to be accomplished effectively, the proper time for cleaning must be determined carefully. Periodic flow tests should be made of the cooling water, and temperatures of the supply water compared with the temperatures of the discharge water. A study of this data, along with visual inspection whenever possible, should enable the operator to determine when cleaning would be most advantageous. The first failures due to improper cooling are a good indication of the necessity of cleaning, because failures of this nature are nearly always followed by others of increasing severity. In some plants it already has been determined that cleaning will be required annually. In other plants, cleaning may be required this frequently in only parts of the cooling system.

OTHER APPLICATIONS OF CHEMICAL CLEANING

Among the first heat exchange equipment to be successfully cleaned through the use of chemical solvents was the steam generator. Since the first such operation, boilers of all types, makes and sizes have been effectively cleaned in periods of time ranging from six to twenty-four hours. The value of chemical cleaning of boilers, in terms of availability factor and availability-capacity factor, has been the subject of separate study and needs to be mentioned here only to point out that such long range considerations do exist. These considerations indicate the cumulative benefit of planned maintenance progress which are built around the chemical descaling method. It has become common practice at the present time to remove a steam generator from service, and in 24 hours to clean the unit chemically, insure neutralization of all surfaces, and inspect and return the unit to production. Due to the inherent advantages and the speed with which such cleaning may be accomplished, chemical scale removal has been used quite extensively in the steam generating field. As a result, considerable progress has been made in technique where boilers are concerned. Solvents and treating techniques now are available for the removal of practically any scale which may be encountered in a steam generating unit.

For the purpose of evaluating the chemical cleaning of boilers, we shall consider a case history of four boilers, each rated at 125,000 lb per hour. These steel plant boilers, previous to chemical cleaning, were cleaned mechanically on an average of once every six months. In the spring of 1945, the four boilers were cleaned chemically, each on separate dates. The average time required for each boiler unit to be out of service because of the cleaning operation was twenty-four hours. Following the cleaning operations, an inspection revealed that at least 95 per cent of the scale deposits from each boiler had been removed by the chemicals. After six months of normal production, the boilers again were chemically cleaned. Inspection and scale analysis indicated that the amount of chemical solvent used in the first operation would not be required for the second cleaning. Therefore, the concentration of the solvent was lowered at the time of its application, and the four boilers again were cleaned on consecutive days. The average down time per unit for the cleaning operation was only 20 hours. This second cleaning operation for the four boilers was done for approximately 62 per cent of the cost of the first job. In addition, it is now evident that the operating time between future cleanings will

Figure 6 — This scale condition can be found in many water lines.

Figure 7 — The pipe of Figure 6 is shown here after chemical cleaning.

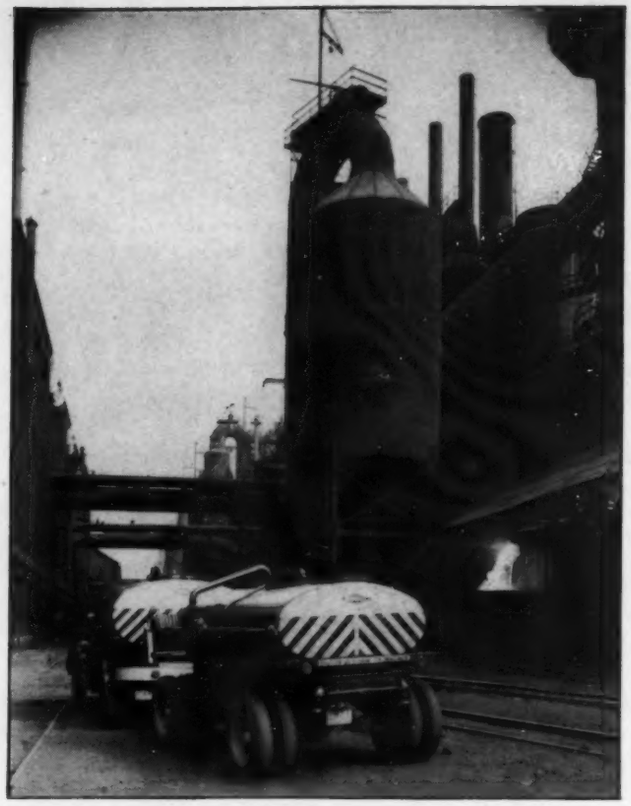

Figure 8 — Special equipment has been developed for handling the solvents used in descaling.

be lengthened. Inspection of the units following 6 months production after their second cleaning indicated that no further cleaning was warranted at this time, and the units were returned to service. This extended operating time between necessary cleanings may be credited to effective scale removal, and, possibly to better operating and water conditions during the period.

Chemical cleaning also has been very effective in removing scale deposits from the cooling systems of open hearth, heat treating, and electrical furnaces. Water cooled doors and frames, and gas damper valves and seats are quickly cleaned while in service, eliminating any down time.

To cite a case history, a deposit consisting mainly of iron oxides, silicates, clay and traces of organic material, of an average thickness of approximately $\frac{1}{8}$ in., was removed from the surfaces of 5 open hearth dampers and seats. A total of 1500 gallons of solvent was used. The procedure followed was that of intermittent filling, with soaking periods of 20 to 30 minutes. This work was completed in 8 hours while the furnace was in service without effecting its operation.

Other equipment which is operated by the steam and power departments of steel plants that is readily adaptable to solvent cleaning are water cooled transformers, electrical precipitators, surface condensers, turbine blades, oil coolers and heaters, various feedwater heaters and systems, feedwater and supply lines, filter beds, evaporators and water cooled jackets of all types, such as engine, compressor and blower jackets. All of these types of equipment have been cleaned successfully through the use of chemical solvents and there is available literature concerning the specific applications. As an example, Figure 6 shows a scale condition typical of the ordinary water line. Figure 7 shows the same section of line after chemical cleaning. Of particular interest to the iron and steel mill operator is a chemical descaling job, which involved the condensers on six turbo-generators. These condensers operated with sea water as the coolant.

Associated coke plants and fabricating mills also are confronted with scale problems. In addition to equipment which has been listed, these departments have other scale problems. In this regard chemical cleaning has been successful in removing deposits from light oil condensers, coolers, gas scrubbers, ammonia stills and condensers, gas lines, wire treating cells, water cooled dies, and other specialized equipment.

In coke plants, the operator is confronted with organic deposits. Unfortunately effective solvents for the removal of many organic deposits, such as coke or carbon, are not available to date. However, continued research for adaptable solvents is showing definite promise. Similar to any mineral encrustation, most organic deposits vary widely in composition. And, again, similar to the mineral deposit, the ones which can be removed may be determined only by an analysis.

The success of chemical removal of scale encrustations which has been experienced in recent years is considered to be a real advance in cleaning methods. Engineers who design heat exchange equipment such

as stationary, locomotive and marine type boilers, now may see their way clear to put into effect many ideas for increasing efficiency and conserving space.

The service companies who render this modern scale removal service have made great strides in designing and building special equipment for the transporting, handling and accurate control of the chemical solvents which are used, in any quantities that may be required (see Figure 8). The present design of such equipment has resulted from many years of experience in the handling and mixing of chemical solvents. The need for accurate blending, concentration and temperature control, and adequately trained personnel is strongly indicated in every chemical solvent application.

DISCUSSION

PRESENTED BY

W. C. SCHULZ, Superintendent Power and Maintenance, Bethlehem Steel Company, Steelton, Pennsylvania

B. H. McDANIEL, Development Engineer, Dowell, Inc., Tulsa, Oklahoma

JOHN J. ALEXANDER, Assistant Superintendent, Steam Department, Corrigan-McKinney Works, Republic Steel Corporation, Cleveland, Ohio

J. C. FOSTER, Combustion Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania

E. C. McDONALD, Combustion Engineer, Republic Steel Corporation, Corrigan-McKinney Works, Cleveland, Ohio

W. C. Schulz: In my opinion, the subject presented should become more and more vital to the industry as the demand on equipment increases.

The author states that "the proper use and knowledge of inhibitors is vital" and also says "mechanism of inhibition is still largely a matter of conjecture." This is the problem of the chemical industry and not of the steel industry. We, in the steel industry, are interested in the upkeep of our equipment, its availability and the operation thereof, and cannot be concerned too much with the problems of the chemist, but we must be assured by the chemical company that the methods used are neither detrimental nor injurious.

I understand that there have been occasions when gases, particularly hydrogen, have been developed during the cleaning process, which, because proper precautions were not taken, exploded when a torch was used to make repairs to other parts of the equipment. The service company should certainly see that all safety angles are covered.

The paper deals generally with steel mill problems, and specifically with certain phases of the operation of blast furnaces, open hearth furnaces, and boiler plants, but I believe further amplification of other specific problems would be most interesting and we would like to understand their approach to the problems and the control processes used.

Commenting on the specific cases mentioned, we all know that it is most desirable in these days, with extreme pressure on production, to have the equipment available at all times. If the outage time, the time required for cleaning and conditioning, can be reduced to an absolute minimum, we have made great gains. If chemical cleaning does this, let us use it.

When you can clean, completely, as stated, the cooling systems of blast furnaces without taking the furnace out of blast, or endangering it by keeping water out of the plates too long, especially in these days when most furnaces have plates extending practically to the top of the stack, and can insure furnace lines for longer periods of operation, vitally needed production is maintained and the hazards which accompany stopping and starting need not be considered. There is no doubt that this can be done, but it will be necessary for the chemical company to analyze thoroughly all phases of the procedure and work in close harmony with the operating people to determine the peculiarities of the plant and find the best method of attack in order to gain the best results, quickly and thoroughly.

Annual inspections of boilers in our plant used to be a source of great worry because of load failures which would crop up when one or more boilers were out of service due to this required outage period. The advent of chemical cleaning of boilers removed a lot of "headaches" and made it possible to clean boilers with elapsed time measured in hours instead of a corresponding number of days, and actually guaranteed plant operations. Inspection of the boilers after treatment indicated a job that was many times better than the old cleaning methods using mechanical tools.

We have had jobs, of several of the types mentioned by Mr. McDaniel, done at our plant, and we feel the results have been excellent and fully up to expectations.

However, before putting the chemicals in your lines be sure they are in good condition. They may carry water when not disturbed but if they are old, chances are you will have many leaks.

B. H. McDaniel: Mr. Schulz spoke of hydrogen evolved during a cleaning operation. It is true that small amounts of hydrogen are generated during a chemical cleaning operation when an acid base solvent is used. For this reason, steps have to be taken to remove the hydrogen gas from enclosed areas where the concentration in air would be built up to an explosive mixture. This mixture, if ignited by flame or spark, would produce an explosion that would be very harmful to the equipment and endanger the lives of those nearby.

This problem is not too difficult if recognized. In closed systems it is usually handled by attaching a vent line to the vessel and venting the hydrogen generated to the atmosphere. In systems that are open, and are located in buildings or some closed area, a definite need for proper ventilation is obvious. Precautions should be taken to prevent any sparks or flames to exist during the cleaning operation.

To my knowledge, there have been only three solvent cleaning operations where the presence of hydrogen has not been controlled. Apparently the hazard was

not realized in each case as the mentioned precautions were not observed. On the other hand, there have been thousands of such operations carried out safely.

John J. Alexander: We have had several occasions to chemically clean condensers in the Republic plants and have found that there is a decided tendency for scale and sludge to re-form much less rapidly than before chemical cleaning.

We have taken extreme precautions to prevent the formation of hydrogen in the steam compartment of the surface condenser. We fill it with water to an elevation, higher than the solution is allowed to go, so there is no possibility of the solvent leaking over into the steam side.

I would like to ask Mr. McDaniel whether the solvent is re-used where it has served partly as a cooling medium, and also whether the inhibitors that you use are equally effective to the various metals to which they are exposed.

B. H. McDaniel: With reference to Mr. Alexander's first question, the solvent is not re-used in those instances where it has served partially as a cooling medium. Concentration of the solvent is determined prior to its introduction into the system, and this concentration is so adjusted that the discharged solvent may be disposed of with very little loss.

Concerning the second question, the inhibitors which are used in any one cleaning operation are, within practrical limits, equally effective for the various metals in the system. The proper inhibitors must be determined prior to introduction of the solvent on the basis of the metals which will be encountered and also on the basis of the temperature range which will be maintained in the system.

J. C. Foster: There have been good results at the Bethlehem plant with chemical cleaning of the stack and bosh sections of the blast furnaces. The hearth and tuyere sections of the cooling systems are cleaned mechanically with very good results. It is felt that mechanical cleaning has a very definite place with other cleaning methods.

There is a situation at one of the furnaces where the cooling water is dirtier than on the other furnaces. On the hearth and tuyere section of this furnace, there is a monthly survey made with a flow meter, and the measurements of inlet and outlet water temperatures. If the flow should drop below normal or the temperature rise be excessive, this section will be cleaned mechanically.

There is another method of checking on the effectiveness of the hearth cooling systems. This method is the use of thermocouples that were placed in the hearth at various depths and points in the furnace. If any of these couples should show a rapid rise in temperature, the cooling system that cools that portion of the hearth will immediately be checked and cleaned, if necessary. There have been occasions when cooling sections have been found completely blocked so that no water will circulate. When this condition arises, chemical cleaning will be of no help because circulation is necessary. It has been found that mechanical cleaning will frequently remedy the trouble.

The circle pipe can be cleaned mechanically by going through the feed pipes into the circle pipe.

There are attempts to improve the cooling water by the use of poly-phosphates and chlorination. The results through the use of poly-phosphates have not justified the effort, but there are hopes for the use of chlorination because of the successful treatment of condenser cooling water by other plants. Of course, the chlorination only helps where biological slides of the water prove the presence of bacteria and other microscopic growths capable of promoting silt deposits and/or corrosion.

In the case of boilers and condensers, there are good results being regularly obtained with chemical cleaning. By cleaning the turbo-generator condenser chemically, recently the efficiency of the generator was improved by 10 per cent.

B. H. McDaniel: Mr. Foster points out that chemical cleaning is not effective on completely blocked passages. This is decidedly true, unless circulation can be established by some means. On blocked passages the chemical solvent would only be in contact with the surface of the plug and the time required for the solvent to penetrate through the constricted area would likely be excessive. Also the problem of keeping fresh unspent solvent in contact with the scale must be considered.

In some cases, such as pipe line or tubing, a specially designed jet tool used with solvent has been used very successfully in removing plugging scale deposits. The jets are designed to produce a hydraulic jetting force with the solvent against the scale, and accomplishes a washing effect as well as rapid chemical reaction by keeping fresh solvent in contact with the deposit. This method is often followed by the conventional chemical treatment.

E. C. McDonald: I agree with almost everything that was said here about the removal of scale for I have seen it work on condensers, boilers, and cooling systems. However, it appears to me that in some cases we are taking care of trouble after it occurs. There are a lot of applications I believe where chemical treatment during the time the water is being used will overcome some of these difficulties.

I know of one case in particular where a phosphate treatment used continuously in the water cooled skids of slab heating furnaces eliminated the need for descaling.

Another application, on the water jackets and coolers of reformed gas machines for annealing, showed the time between descaling periods could be greatly increased by continuous chemical treatment.

I would like to hear from some of the chemical men if any are present on what they are doing to prevent or retard the deposition of scale. I recognize that a continuous treatment is not applicable to turbines, boilers, condensers and similar equipment but in the field of cooling as at blast furnaces, open hearths and the like, I feel there is a need for treatment to retard the deposition of scale.

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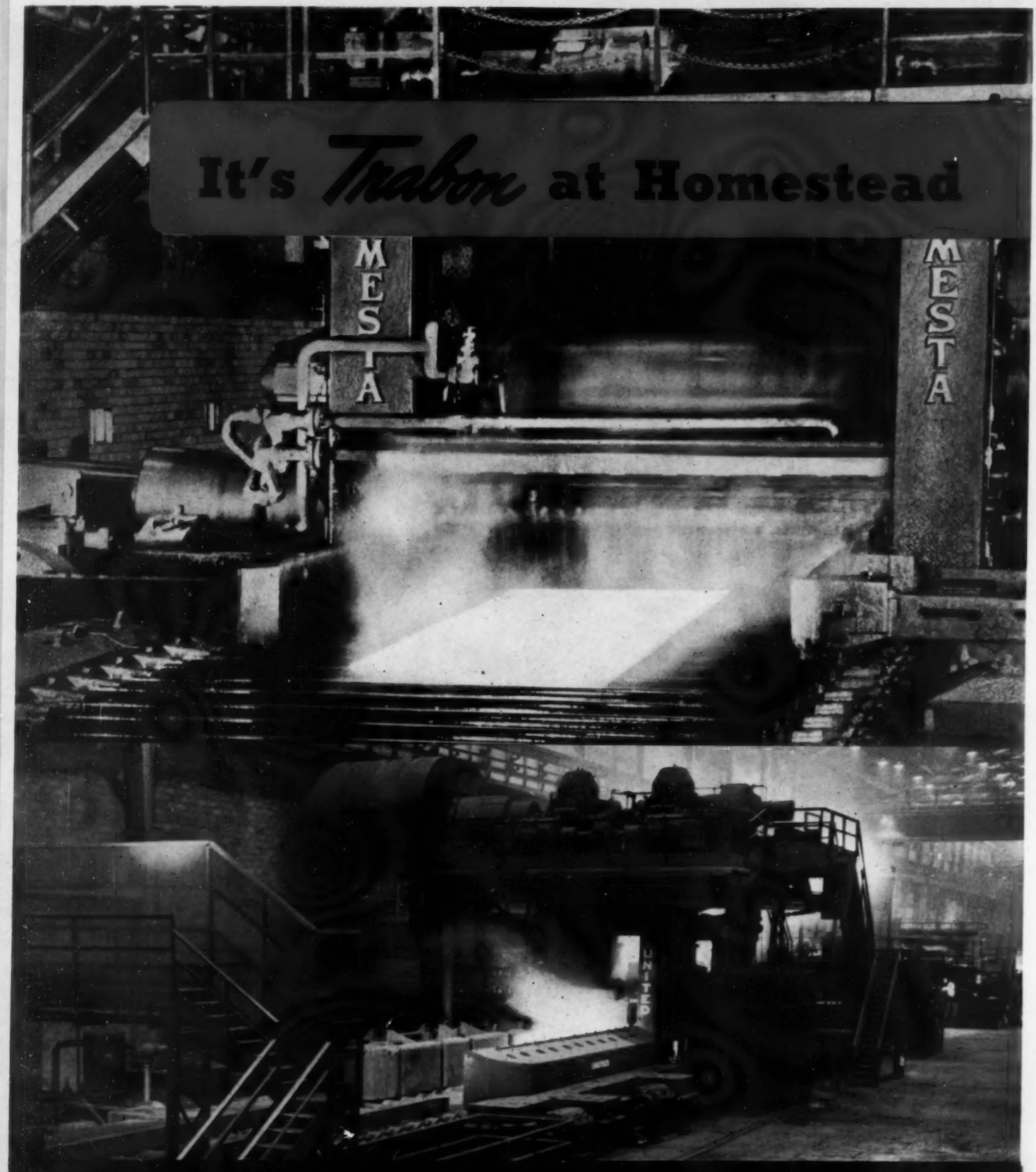

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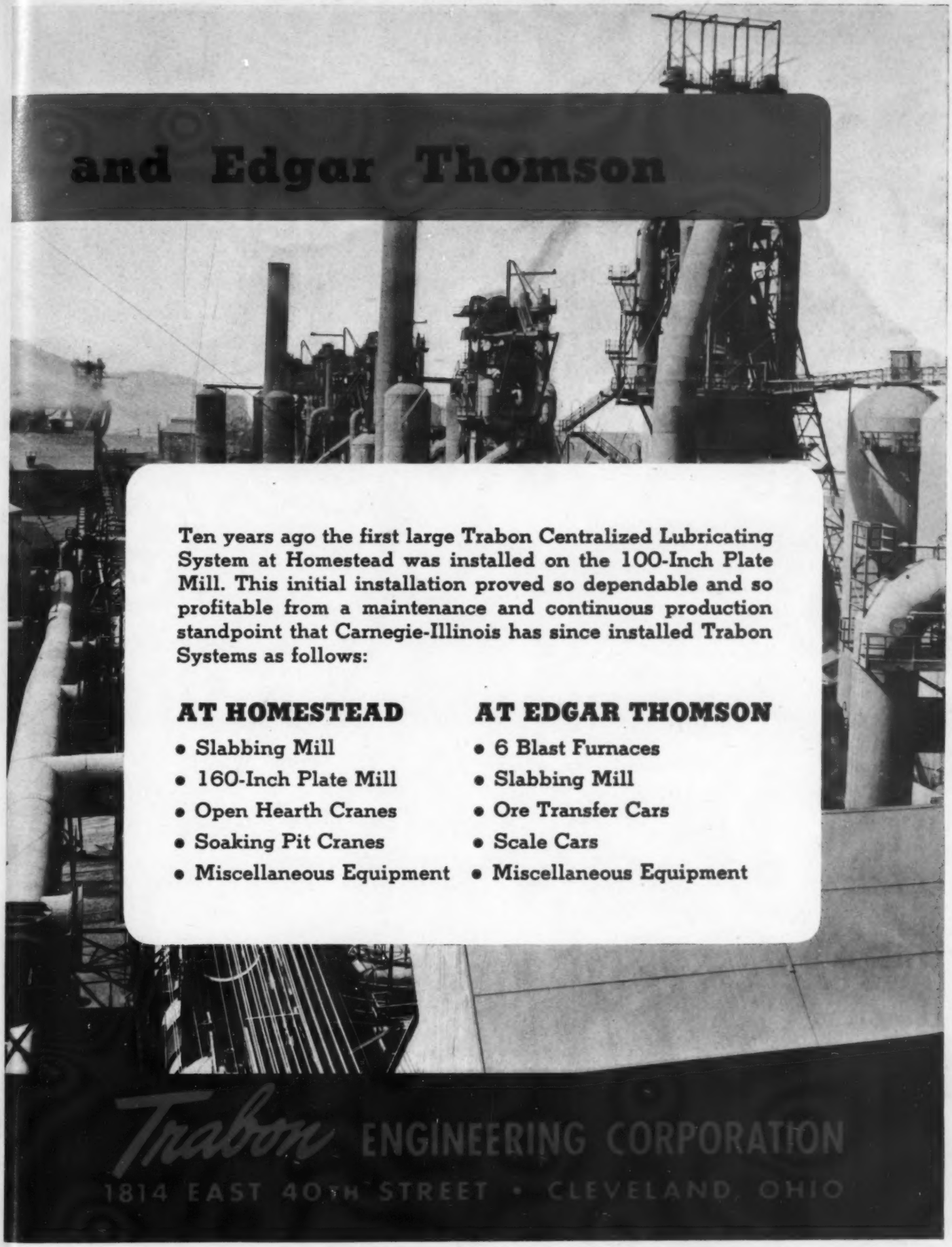

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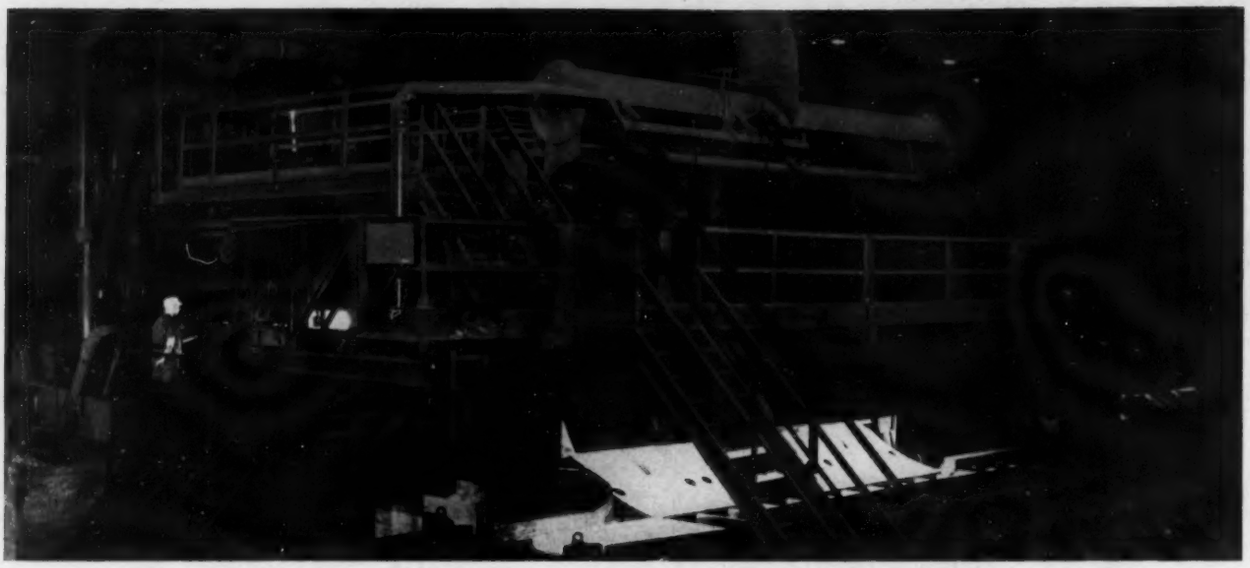

Discharge end of two Rust patented triple fired, zone controlled, continuous slab reheating furnace. Homestead Plate Mill.

TYPICAL RUST INSTALLATIONS

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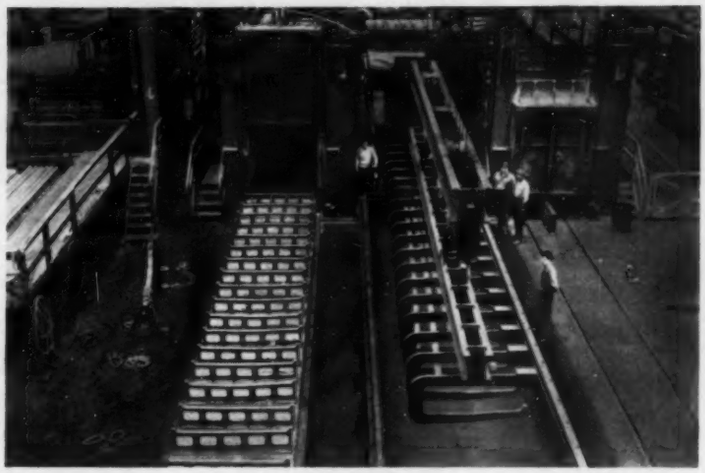

Bar stock heat treating and annealing furnaces of car bottom type. Five installed at Duquesne Works.

Furnace for thawing ore in cars. Edgar Thomson Works.

Car bottom type heat treating and forging furnaces. Homestead Forging Shop installation included 15 of this type.

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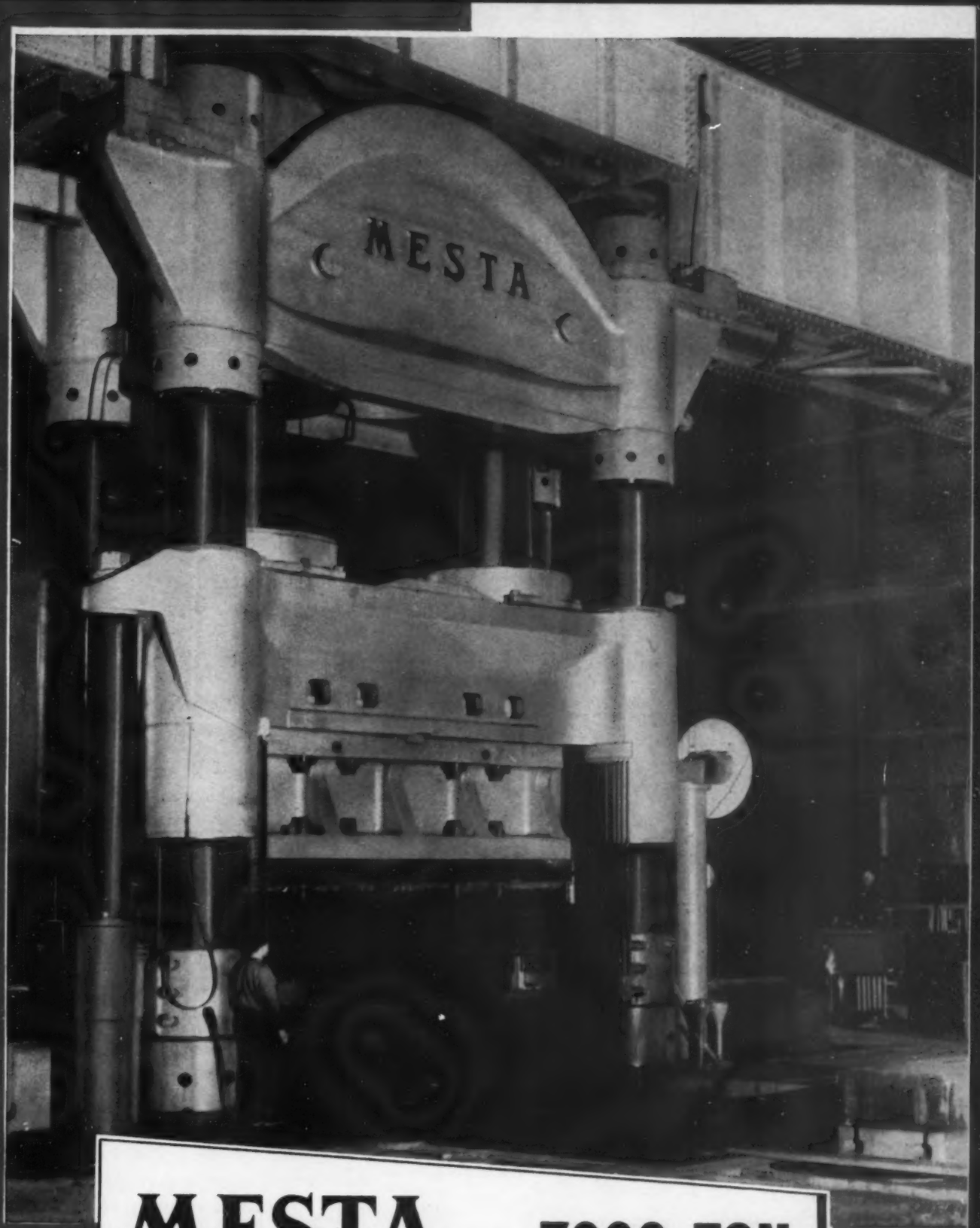

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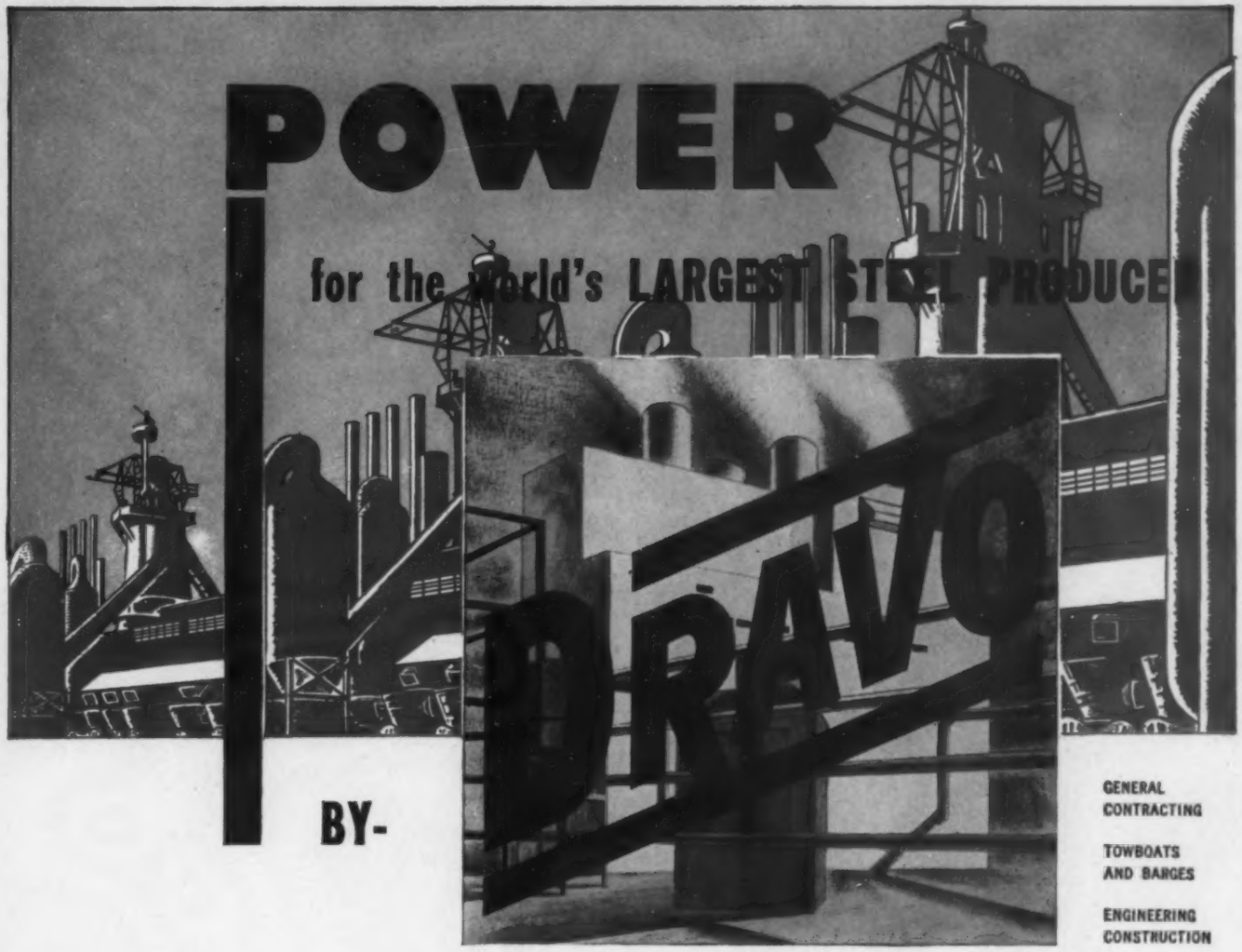

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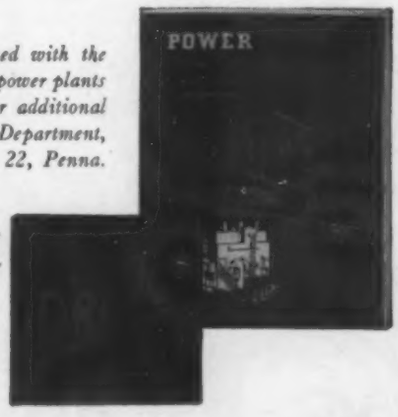

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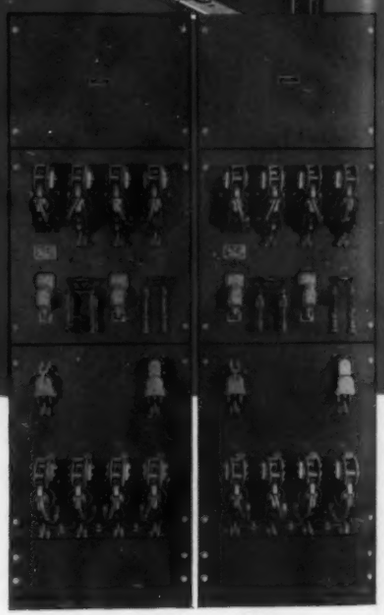

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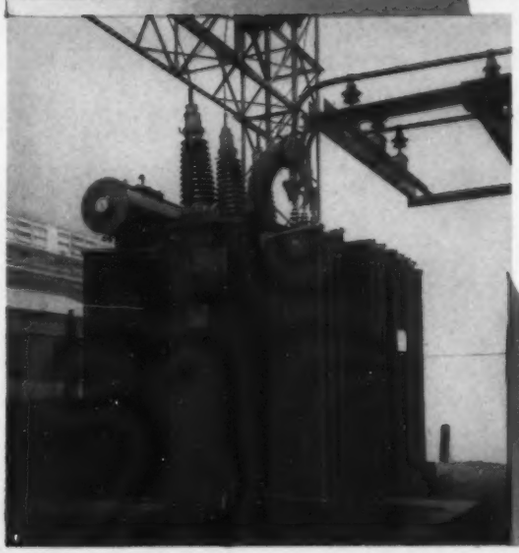

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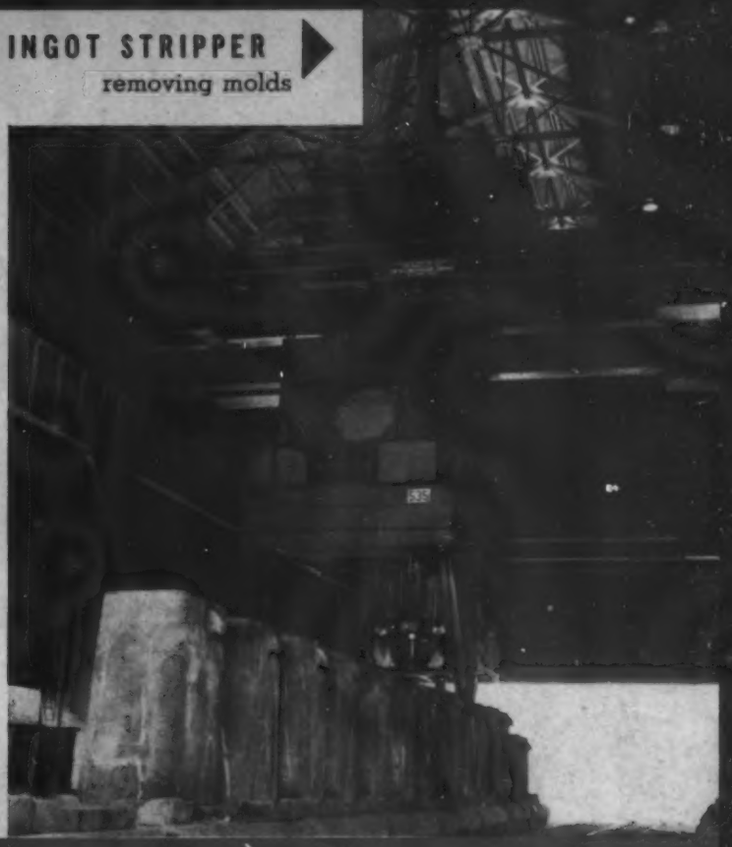

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• **BLAST FURNACE RECORD**—A new world's blast furnace record was made in July by the No. 2 blast furnace at the Edgar Thomson Works of Carnegie-Illinois Steel Corp., with a production for the month of 50,590 tons. The previous record was held by Great Lakes Steel Corp., which has a furnace that produced 49,705 tons in 1943. The new record is more unusual because it was made without scrap charges, according to the company. In making the new monthly record, the furnace set two new weekly records and a daily record. The best weekly record was for the week ending July 26, when 12,189 tons of pig iron were produced and the best daily record was made on July 12, when the output totaled 1976 tons or 48 pct over the 1330 ton rated capacity of the unit. The monthly production was 23 pct over the rated capacity of the furnace.

REPRINTED FROM IRON AGE, AUG. 9, 1945

THE photograph reproduced above shows the No. 1 and No. 2 blast furnaces at the Edgar Thomson Works of Carnegie-Illinois Steel Corporation. These furnaces were designed and constructed during the war by Arthur G. McKee & Company. The record referred to in the clipping was made by the No. 2 furnace shown at left.

10 ROCKEFELLER PLAZA
NEW YORK, N. Y.

Arthur G. McKee & Company

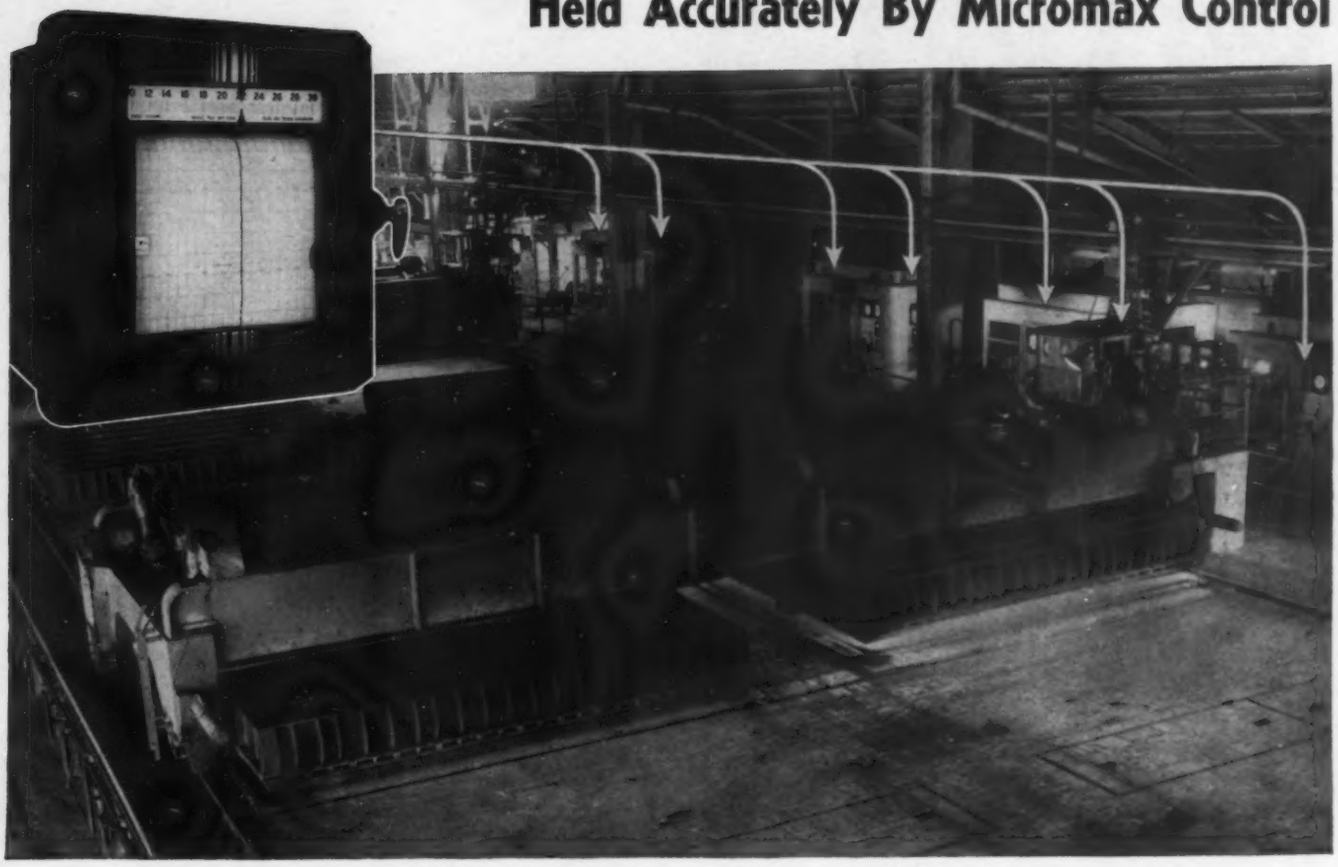
★ *Engineers and Contractors* ★

2300 CHESTER AVENUE · CLEVELAND, OHIO

McCORMICK BUILDING
CHICAGO, ILLINOIS

SOAKING PIT TEMPERATURES

Held Accurately By Micromax Control



Lifting the cover off one of twenty Micromax-controlled Amsler-Morton soaking pits at Homestead Works. Pits are fired with blended gas which may range from coke oven to straight natural gas.

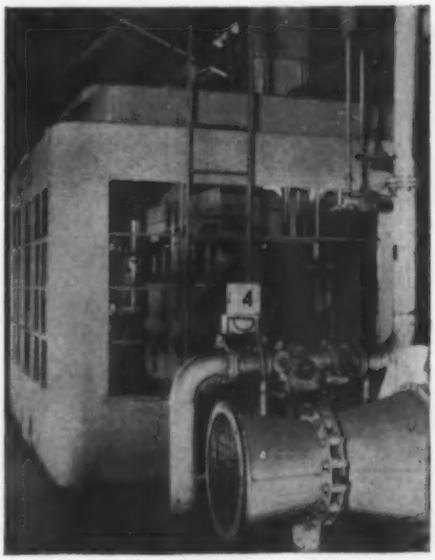
The Micromax soaking-pit controls pictured above are the proportioning type with full automatic droop-correction (reset), and operate electric-motored drive units which throttle the gas valves (see picture at right).

With this complete, automatic temperature control, long-time changes in heat demand are handled just as promptly and precisely as are any sharp, sudden changes from full charge to stand-by operation. Control can be switched readily from full automatic to remote manual, using a dial on the Micromax Electric Control Unit as a remote valve-position indicator. Temperature regulation can thus be varied to meet operating conditions, with the result that ingots are sure to be ready for the rolling mills exactly at specified temperature, and fuel efficiency is maintained.

Applied here to gas-fired pits, Micromax Control functions equally well on oil-fired furnaces, and can be used with L&N or any other fuel-air ratio set-up. Fully wired and ready to install, Micromax Control comes as a complete factory-assembled and tested unit.

If you have a temperature control problem on hand, an L&N engineer will be glad to call. Or, if you prefer, we'll send Catalog N-33A.

Leeds & Northrup Company, 4942 Stenton Avenue, Philadelphia 44, Pa.



L&N Electric Drive Unit linked to gas valve adjusts fuel input as directed by Micromax Controller inside cubicle.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Jrl. Ad N-33A-667(1)

14 PORTER

Diesel-Electric

LOCOMOTIVES

Fourteen Porter Diesel-Electrics are now in service at the Carnegie-Illinois Steel Corporation's Homestead Works: six 35-ton and six 60-ton 30" gauge units, one 65-ton and one 80-ton standard gauge unit.

Porter Diesel-Electrics have *proved* their economy and reliability in steel plant haulage—the toughest service ever asked of switching locomotives. Because of their rugged construction and many advanced features of design, Porter Diesel-Electrics provide practically 100% availability.

Porter engineers will be glad to survey your haulage problems and recommend the type of switcher best suited to your own particular requirements.

H. K. PORTER COMPANY, Inc.

PITTSBURGH 22, PENNSYLVANIA

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PORTER Better-Built Equipment Established 1866

Porter-Built means "Better-Built"

WAR TIME EXPANSION OF
CARNEGIE-ILLINOIS STEEL CORPORATION
IN THE PITTSBURGH DISTRICT

. . . . offhand, one might not consider that a complete new steel plant was built in the Pittsburgh district during the recent war . . . . however the additional blast furnaces, electric and open hearth furnaces, and rolling mill facilities built for the Defense Plant Corporation by the United States Steel Corporation, through its subsidiary the Carnegie-Illinois Steel Corporation, added more basic capacity to the industry than some of the more spectacular wartime plants . . . .

By T. J. Ess

▲ ONE of the important steel plant expansions completed during World War II was that built for the United States government by the Carnegie-Illinois Steel Corporation in the Pittsburgh district, and subsequently purchased from the government by this United States Steel Corporation subsidiary. This project, although practically equivalent to a complete integrated steel plant, is divided between three existing Carnegie-Illinois plants: Homestead, Duquesne and Edgar Thomson.

The major portion of the expansion is at Homestead, where a new open hearth shop, slabbing mill, plate mill and forge shop were built. The site is an area of 123 acres adjacent to the previously existing Homestead works, and the new construction required the razing of 1200 buildings and the moving of Howard axle shop, a

The open hearth high line feeds into the charging floor and into the stockyard located to the right of the open hearth stacks. Fuel oil tanks are shown along the trestle.

The open hearth shop, which contains eleven 225-ton furnaces, is well laid out, with ample room to insure uninterrupted sequence of operations and maintenance work.

division of Homestead steel works to a new location 16 miles down-river.

OPEN HEARTH FURNACES

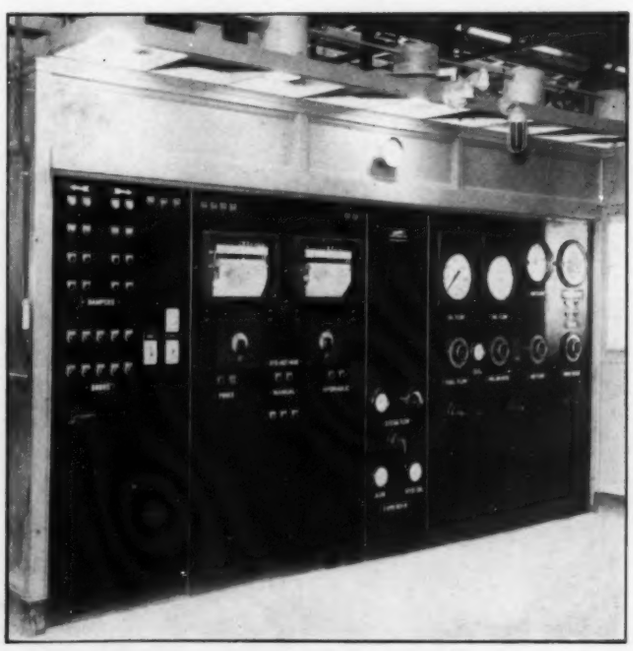
The open hearth installation, which consists of eleven 225-ton furnaces, is housed in a group of buildings which form six parallel spans. Main building columns are supported on piling, steel piling being used for columns adjacent to the furnaces, and concrete piling for others. Other building columns are carried on concrete footers. The main building, 162 ft wide, is divided into an 85 ft charging floor 1404 ft long, and a 77 ft pouring aisle which is 1944 ft long. Main building columns are spaced on 108 ft centers, allowing space between for one furnace in each of eleven bays. On the charging floor are three 12-ton charging machines and two 150-ton hot-metal cranes. Three 300-ton ladle cranes handle pouring operations in the pouring aisle, and two 75/25 ton cranes are also installed for miscellaneous work.

The furnaces are 87 ft long overall, and provide hearth dimensions of 18 ft × 52 ft at the fore-plate line. Furnace bottoms consist of 3½ in. of insulating cement, topped by 9 in. of first quality fire brick in the center of the furnace, stepped up to 13½ in. at the ends. Next comes a 12 in. layer of burned chrome brick and finally a rammed bottom of 15 in. thickness.

In the front walls, chrome brick extends 10 in. above and 8 in. below the sill line, while the backwall, sloping at an angle of 51 degrees, has 22½ in. of chrome-magnesite brick at the sill line and is coated with about 4 in. of rammed refractory. Five charging doors, each 5 ft 1 in. wide × 4 ft 3 in. high, permit entry of the 44 cu ft charging boxes.

Skewbacks, 5 ft 1 in. above the sill line, support the roof, which has a rise of 3 ft 3 in. in its 22 ft 5½ in. span. Roofs are generally built of 18 in. × 6 in. × 3 in. silica brick with every fifth course a rib 22½ in. thick.

All controls and instruments for each furnace are mounted on a panel board which forms the front wall of a control house. Automatic control is provided for fuel and air flow, furnace pressure, roof temperature and furnace reversal.



Roof span is 22 ft 5½ in. Some roofs use these thicknesses only at the shoulders, with the balance of the roof made of 13½ in. brick with 18 in. ribs. Cross-sectional area of the furnace above the foreplate line is 153 sq ft.

Furnace throats are 11 ft 6 in. wide at the bottom, 13 ft wide at the top, and provide an area of 88.6 sq ft. The arch has a rise of 2 ft 3 in.

Furnace ports are 16 ft long × 18 ft wide, covered by a horizontal section of roof 9 ft long and a sloping section 8 ft long with a pitch of 6¼ in. per ft. The horizontal section of the port roof is 9 ft 3 in. above the foreplate line, and has a rise of 2 ft 3 in.

Two downtakes at each end of the furnace, each 9 ft long × 6 ft wide, are located 3 ft 6 in. to 3 ft 9 in. above the foreplate level. The oil burners project into the furnace a distance of about 11½ ft.

The single slag pocket on each end of the furnace is 18 ft 6 in. wide (15 ft 3 in. between false walls) × 21 ft long × 16 ft 4 in. high. Along the floor of the slag pocket, which is about 26 ft below charging floor level, a narrow tunnel is built running 11 ft back from the bulkhead. A heavy beam may be inserted in this tunnel and used as a lever to break up accumulated slag.

Double regenerator chambers are provided on each end of the furnace, each chamber 13 ft 4½ in. wide × 30 ft long × 25 ft high. Actual checkerwork in each chamber is approximately 13 ft × 30 ft × 14 ft, giving about 11,000 cu ft at each end of the furnace. Nine of the furnaces have checkers with straight 7½ in × 7½ in. flues. Two furnaces have checkerwork of special design with 9 in. × 7 in. flues.

Waste gases from the regenerator chambers flow through two separate flues (each of 33.4 sq ft sectional area), through two reversing valves, and into a common flue of 45.9 sq ft area. All underground flues have 13½ in. brick walls, with 4½ in. of insulating concrete outside the brick. The main flue conducts waste gases to a 7500 sq ft horizontal fire-tube waste heat boiler, which operates at 300 psi pressure and 625 F total steam temperature and produces about 1120 lb of steam per ton of ingots. This steam which normally totals about 165,000 lb per hr, is used for water pumping, heating and atomizing fuel oil, and building heating. From the boiler, an induced draft fan rated at 51,000 cfm, 7 in. water column at 550 F, exhausts gases to a stack 150 ft high × 7 ft inside diameter.

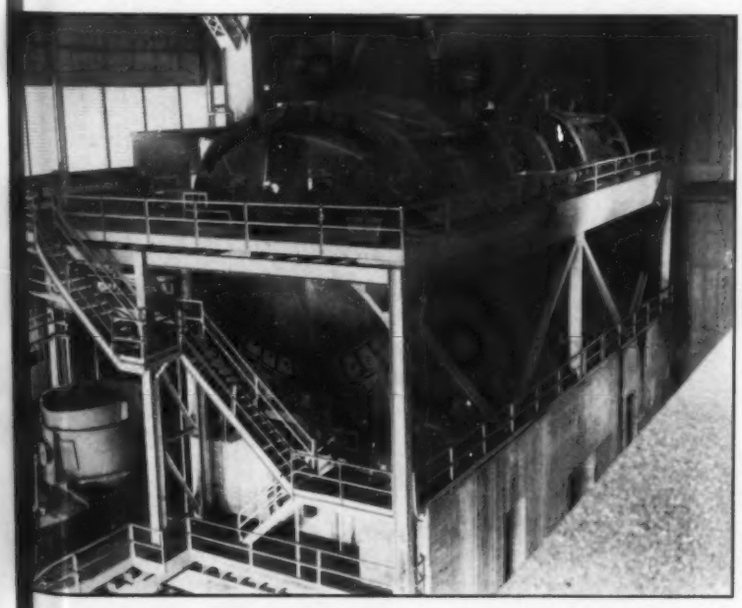
Built into the floor of the regenerator chambers and of the flues at intervals are soot blowers, operated on 300 psi steam, to blow flue dust progressively toward the stack.

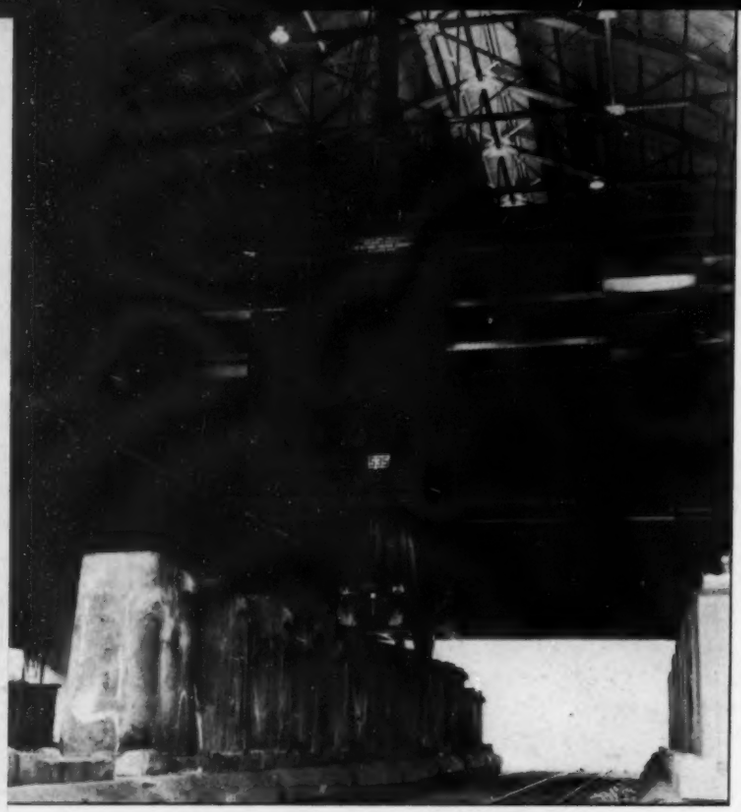
Air for combustion is introduced into the furnace system at each of the reversing valves, being supplied by a forced draft fan rated at 20,000 cfm at 32 in. water column.

The furnaces are water-cooled to a considerable degree, including doors and frames, main buckstays on both sides of doors, and the front skewback where archless door frames are used. Pipe coolers are built into monkey walls and in the upper portion of each bridge wall. A cooler is located in the end wall, at each down-take, and the burner dog-house has water cooling in its roof, side walls, and nose. Water from these points flows into four boshes on each furnace, and a portion

Three 300-ton ladle cranes handle the pouring operations. Facilities are provided for either direct or basket pouring. In addition to three pouring platforms, there is a casting pit where ingots weighing up to 260 tons may be poured.

Hot metal from the blast furnaces is transferred into two 800-ton oil-fired mixers. The metal is moved from the mixers to the open hearth furnaces by 100-ton ladles mounted on cars.





Ingots are stripped by two 200-ton stripper cranes which can handle either big-end-up or big-end-down ingots.

of it is then used for cooling reversing valves and stack valve.

Under the furnaces, running between the regenerator chambers is a track which permits passage of a cinder pot car from the pouring aisle to a position below the center charging door of the furnace. The sill plate of this door is designed to permit the removal of slag. Thus, slag may be removed from both the front and the back of the furnace, speeding up this operation materially.

A 7½ ton jib crane is installed on the tapping side of each furnace.

Controls and instruments for each furnace are grouped on a panel which forms the front wall of a control house. The controls are designed to maintain constant fuel flow, as set by the operator on a dial on the panel. Likewise, air flow is held constant by controls which operate vanes in the inlet of the forced draft fan. A control is also provided to maintain constant fuel-air ratio if desired.

Furnace pressure, measured near the center of the roof, may be maintained automatically at any desired value as selected on a dial on the panel board. Pressure changes are effected by changing the position of louvers in the inlet to the induced draft fan. Normally, a pressure of 0.11–0.14 in. of water is maintained.

Furnace roof temperature is measured by a radiation type pyrometer so mounted as to sight through the back wall on a point near the center of the underside of the roof. When this temperature exceeds a desired maximum, fuel input to the furnace may be automatically reduced. Similar radiation units are installed so as to sight upon the top of the checkerwork in each regenerator chamber. Should temperatures recorded by these units exceed desired limits, the furnace is automatically reversed, even though the regular floating temperature limit, which normally functions to balance temperatures at each end of the furnace, does not call for reversal. Also, the furnace is automatically reversed on maximum time intervals even though temperatures do not call for it, and at the same time, the floating control temperature setting is automatically reduced to the temperature then existing. If the checkers reach the floating control temperature in less than the desired minimum time, reversal does not occur until the minimum time has elapsed, but the floating control temperature is automatically raised to checker temperature at the time of reversal. Manual reversal by pushbutton is also available.

A flame radiation pyrometer, mounted on a portable carriage may be moved from one furnace to another to determine the effectiveness of flames in the furnaces under varying operating conditions.

Fuel for the open hearth consists entirely of bunker C oil. Received in tank cars, the oil is drained into track pans, flows by gravity to a sump, and is pumped by two 300 gpm pumps into the oil storage tanks. At present oil storage consists of three 500,000 gal tanks, and two 1,250,000 gal tanks are under construction. Tank heaters maintain oil temperature at about 120 F, while three line heaters, each with 822 sq ft of heating surface, in the recirculating system are able to hold oil temperature as high as 240 F. Four 200 gpm pumps, three driven by motors and one by steam, are installed to handle the oil through the system.

Fuel consumption averages 3,260,000 Btu per net ton of ingots, although a monthly record of 2,910,000 Btu per ton has been established.

The rated capacity of this open hearth shop is 1,700,000 net tons of ingots per year. During 1946, with an average of 9.4 furnaces operating, 1,421,465 tons of ingots were produced. The record monthly production now stands at 152,607 tons, produced by 10.9 furnaces. A rate of 18.5 tons per furnace operating hour is usually maintained.

Steel is made in a wide range of grades, both rimmed and killed, and is poured into a variety of ingots ranging from 26 in. × 48 in. up to 39 in. × 72 in. in size, and from 15,500 lb to 70,000 lb in weight. Most common is a 29 in. × 66 in. ingot weighing about 40,000 lb, although many 34 in. × 66 in. big-and-up ingots of about 50,000 lb are also cast.

MATERIALS HANDLING

Noteworthy in the layout of this open hearth shop are the steps to provide for economical handling and uninterrupted flow of materials through the process. The arrangement of the charging floor is such that charging buggies can be shifted between the stockyard tracks and the charging track without interference or confusion. Standard railroad cars may also be handled on the charging floor without interfering with charging machines. Hot metal comes to the lower level of the shop in 75 ton standard gage ladle cars from Carrie blast furnaces, about three miles distant. At the open hearth these ladles are lifted from their cars by a

125-ton overhead crane, and the metal is poured into either of two 800-ton oil-fired mixers which are located in a building, 88 ft 6 in. × 164 ft, at the end of the open hearth building. Metal from the mixers is poured into 100-ton ladles mounted on cars. These cars are shifted by an electric locomotive to the desired furnace, where the ladle is picked up and emptied into the furnace by overhead crane. Hot metal forms about 66 per cent of the open hearth charge.

Scrap and pig iron are brought in gondola cars onto the upper level of the 88 ft × 1134 ft stock yard, where they may be unloaded by magnet crane directly into charging boxes or to the stockpiles on the ground level. This yard is entirely under roof, and is served by four 10-ton cranes. Three parallel tracks are provided on the upper level of the yard, and a track scale permits weighing of scrap charges.

Raw dolomite is received on the upper level of the charging floor in hopper cars, and is discharged into six 60-ton bins. From here, dolomite is carried by belt conveyor and bucket elevator to an overhead bin 40 ft above charging floor level, and then chuted into dolomite machines or into boxes for transfer by crane to desired points along the charging floor. Burned dolomite comes in container cars directly to the charging floor.

Three 450 cu ft dolomite machines, operating on standard gage railroad track, are used for bottom repairs.

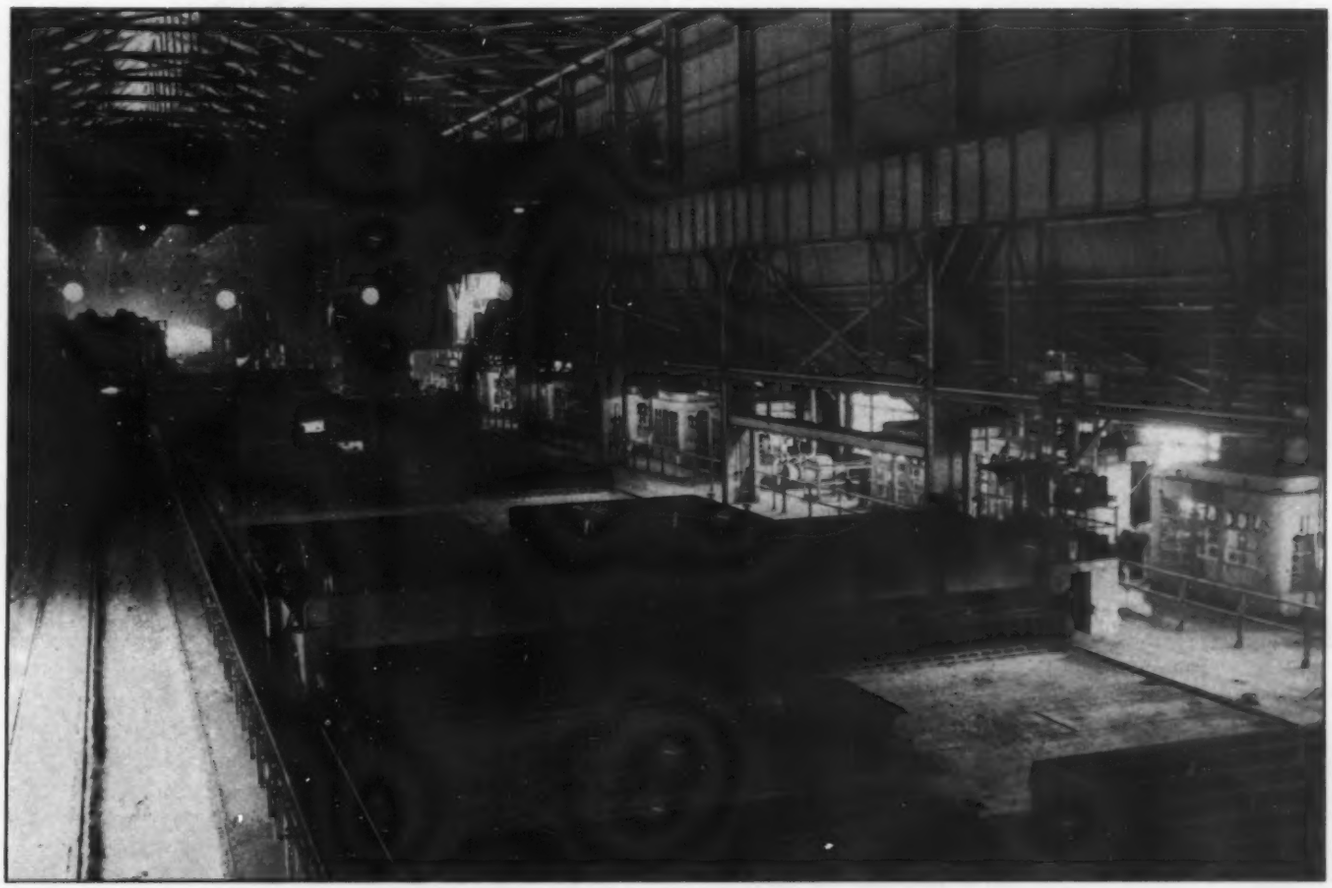
Ferromanganese and ferrosilicon are brought onto the charging floor in gondolas or box cars, and unloaded into a crusher car which delivers the crushed material into bins on the lower level. These materials are then chuted into transfer boxes which are moved by crane to bins behind each furnace. Other alloys are unloaded from trucks or railroad cars into bins along the charging floor columns. A two-ton electric truck moves these materials to scales, where, after weighing, furnace additions are put into charging boxes and ladle additions are put into drop-bottom boxes which are handled at the furnace by jib crane.

Limestone and ore are delivered on the charging floor in hopper cars which discharge into 20 bins located below the charging floor at the west end of the building. These materials are chuted into charging boxes which are then shifted up to the upper level.

At one end of the building are grouped a press for straightening stopper rods, a blacksmith forge, benches for building rods, and a drying oven, through which the assembled rods are moved in a vertical position on a conveyor chain.

A dryer is installed for preparation of anthracite coal used for recarburization. In this unit a bed of coal of the desired thickness passes slowly over a sloping vibrating screen while hot air is blown up through the coal. The dryer will reduce moisture in the coal from 8 per cent to 2 per cent at a rate of 2000 lb per hr. Coal is brought from a hopper to the dryer by a small

Heating facilities for the 45 in. slabbing mill consist of 20 recuperative bottom-fired pit furnaces operated under complete automatic control. The pits are fired with a mixture of natural and coke oven gas.



Ingots are carried from the pit furnaces to the slabbing mill approach table by an ingot car which operates under adjustable voltage control and can attain a speed of 700 fpm.

conveyor, while the dry coal is delivered from a small spout into bags.

Steel may be tapped into 225-ton ladles of either single or double stopper types. In addition to three large pouring platforms, the pouring pit also contains a casting pit, approximately 285 ft long × 20 ft wide × 21½ ft deep, where large ingots, up to 260 tons, may be poured. This pit is arranged for basket pouring, with the small ladle carried in a 35-ton motor-driven carriage. Four slow-cooling pits are built into the large pit, each provided with a cover so arranged as to permit some regulation of the cooling rate by varying the amount of air drawn through them by natural convection. There are also six annealing pits 14 ft × 15 ft × 18½ ft deep, fired through burners on each side. Waste gases exit at the four corners of the pits, and pit pressure is automatically controlled. Openings in these pit covers permit air for cooling to enter at a rate determined by the automatically controlled pit pressure. Thus, large ingots of special analyses may be cooled according to almost any desired time-temperature cycle.

Between the stock yard and the main open hearth building is a lean-to bay, 60 ft × 1404 ft. On the lower level in this bay are the waste heat boilers, induced and forced draft fans, a refuse track, and the stack bases, while the upper level carries three tracks for handling charging buggies. No overhead cranes are installed in this bay. Two carbo-analyzer buildings are located in this bay, providing facilities for rapid preliminary carbon determinations. A pneumatic tube conveyor system connects these buildings to the shop chemical laboratory and to the main chemical laboratory of the plant, and teletype communication also connect these points.

On the other side of the main building is an ingot run containing two tracks where drags of ingot buggies may be held, and adjacent to that is the mold yard, a building 88 ft × 1350 ft, served by two 25/10 ton cranes and one 60/25 ton crane. Here are two stands where molds are sprayed with tar, and two lines of hot topping platforms. One-ton wall cranes are used in handling hot tops.

At the end of the mold yard is a cinder yard, 88 ft × 432 ft, served by two 60-ton cranes, and a scrap drop 88 ft × 216 ft, served by two cranes, one of 30 tons and one of 50 tons capacity.

After solidifying, ingots are moved to the stripper building, 70 ft wide × 246 ft long, where two 200-ton stripper cranes, capable of stripping big-end-up or big-end-down ingots, are installed. The stripped ingots are then moved on their cars to the soaking pit building, approximately 600 ft long and 100 ft wide, with a 16 ft lean-to. Three 25-ton pit cranes handle ingots into and out of the pits.

PIT FURNACES

Twenty recuperative, bottom fired pit furnaces, each 15 ft, × 16 ft × 13 ft deep, are installed in ten rows of two pits per row, but the furnaces are of individual construction with a ventilating space between. Mixed coke-oven and natural gas is introduced to each pit through a single firing port 39 in. in diameter in the middle of the furnace bottom.

Two recuperators, composed of octagonal refractory tubular elements, are installed on each pit, providing a total heating surface of 3660 sq ft of heating surface per pit. Air for combustion is heated to 1400-1500 F, while waste gases are reduced to about 800 F. One fan, rated at 6000 cfm, 6 in. water column, is installed for each pit. A brick stack, 100 ft high and 5 ft inside diameter, serves each pit.

The pits are provided with a full set of automatic controls. Temperature control permits top rate of firing until the temperature approaches the predetermined control level, when gas flow is reduced in regular increments, until the ingot is soaked out at the desired temperature. When the pit cover is raised, gas is automatically shut off and does not come on again until the cover is replaced. An emergency gas shutoff is installed to operate in case of power failure to the forced draft fan.

Fuel-air ratio originates from orifice plates in the gas and air lines, which set up differential pressures which act on regulator diaphragms suspended on an adjustable fulcrum. If the gas varies in quality, a density control regulator adjusts the fuel-air ratio regulator accordingly. Furnace pressure is maintained constant through automatic regulation of a damper in the waste gas flue. Fuel gas pressure is likewise held constant by automatic control.

Pit covers are handled by three double span cover carriages. Each carriage is a double girder bridge spanning the double row of furnaces. All controls are contained in a cab on one end of the carriage.

Coke breeze for pit bottoms is dumped into a receiving pit and loaded into drop-bottom buckets, which are transferred to the pits by transfer car and pit crane. A spade-type tool manipulated by the pit crane is used to scrape bottom cinder through four cleanout holes in the pit. Cinder buckets under the pits collect the refuse and are then moved by an electric lift truck through

the tunnel running the length of the building to a pit, where they are hoisted and dumped into cars.

Four or six ingots are usually charged into a pit, depending on their size. Heating time may range from 3–18 hr, depending on the size of the ingots and their charging temperature. Only about 10 per cent of the ingots charged are cold. Fuel consumption averages about 500,000 Btu per net ton of ingots heated. Some stainless steel ingots are also heated here.

45 IN. SLABBING MILL

From the pits, ingots are carried to the mill tables by an ingot buggy of 9 ft 10 in. gage. The car is driven by two 100 hp shunt motors under adjustable voltage control, and attains a maximum speed of 700 fpm. The tilting pot, which can handle a 70,000 lb ingot, places the ingot onto two driven table rollers mounted on the buggy. The car has a maximum travel of 450 feet from the farthest pit to the ingot receiving table. About 50 seconds are required for this run.

The ingot then travels over about 112 ft of approach tables driven through line shafts at speeds ranging 212-405 fpm. Roller bearings are used on the rollers, line shafts and drives. A device for weighing the ingots and turning them end-for-end is installed in the approach table.

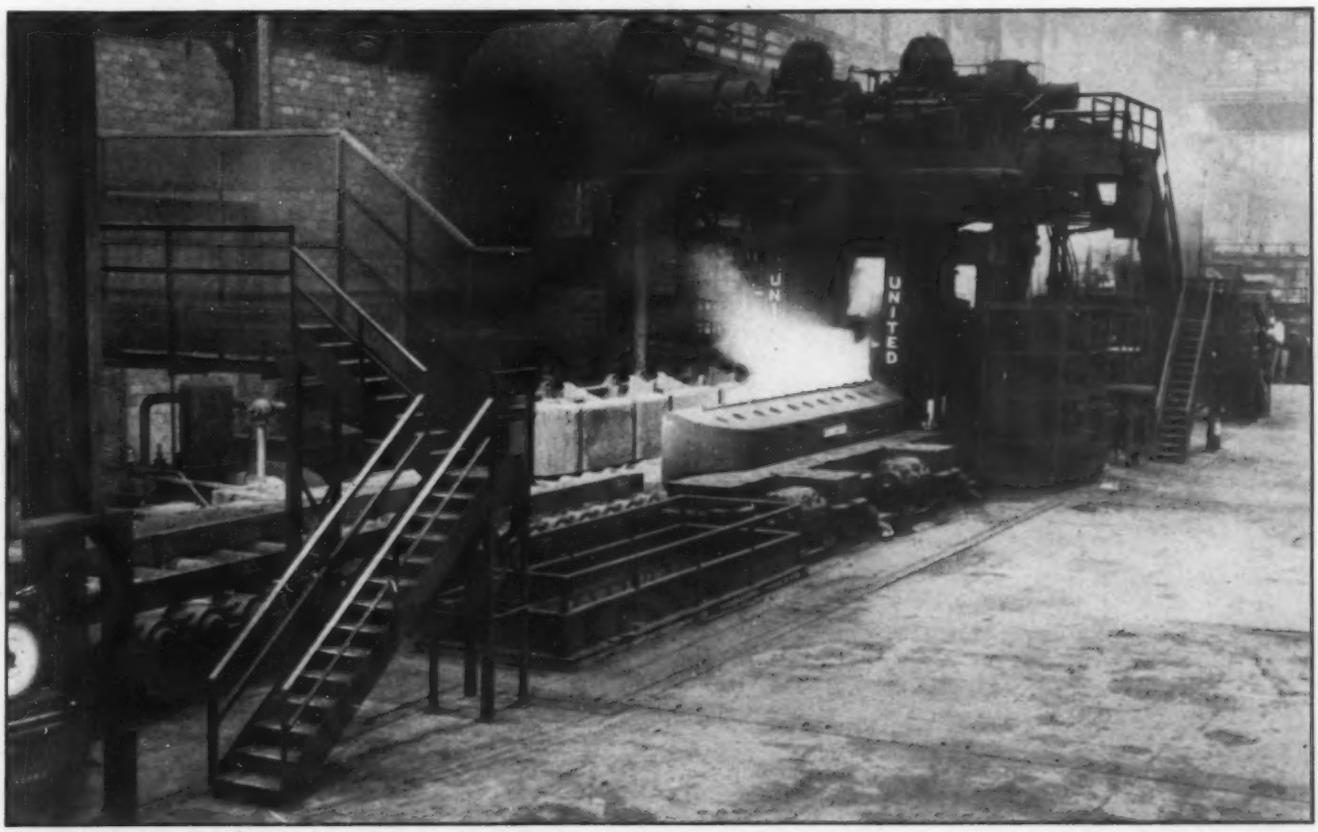
The slabbing mill is of the universal type, with vertical rolls integral with the main mill housing. The horizontal rolls are 45 in. in diameter × 80 in. body length, and are mounted in roller bearings, the first such application in a primary mill of this type. The rolls are moved by screws of 18 in. diameter and 2¼ in. pitch, driven by two 200 hp d-c motors under adjustable voltage control through gearing which gives a roll lift speed of 26 fpm at 615 rpm of the motor. This high lift speed is used because the mill is designed for a high roll lift for edge rolling, another unusual feature in a universal mill. The top roll and spindle are balanced by a counterweight.

The twin drive for the horizontal rolls consists of two 5000 hp, 40-80 rpm, 700 volt single armature reversing motors, one motor connected directly to each roll. A rolling speed of 470-940 fpm is thus provided. The motors are connected to the rolls by forged alloy steel universal mill spindles, 23 in. in diameter and 33 ft 1 in. long. The bottom spindle is carried on two 29 in. diameter babbitted bearings, spring balanced in cast steel bases. Two forged steel carrier bars with two 29 in. babbitted bearings support the top spindle.

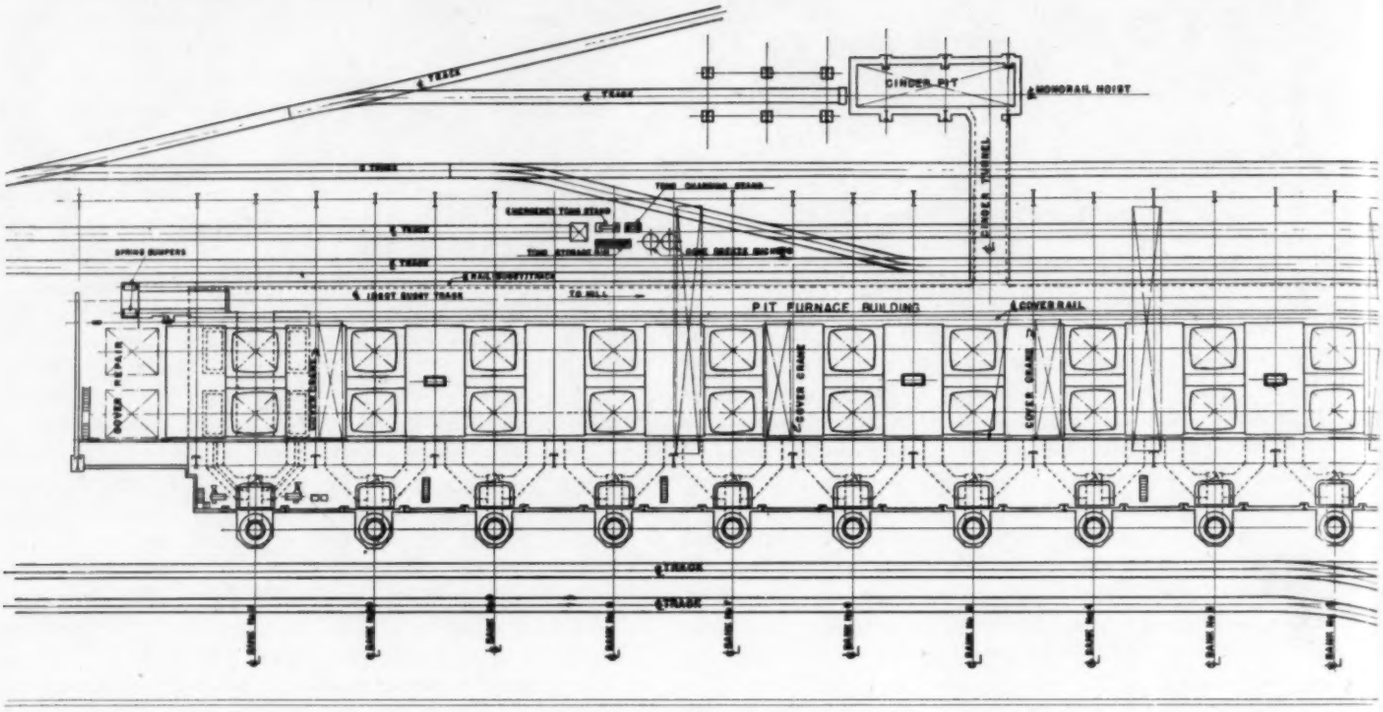
Vertical rolls, 36 in. in diameter, are attached to the main housing and operate in bronze bearings. They are driven at 60-180 rpm through an overhead gear reduction by a 3000 hp, 60-180 rpm, 700 volt reversing motor. The overhead roll drives move with the edger rolls, and are operated by the same adjusting drive used for positioning the rolls. Two 75 hp motors move the vertical rolls, and a roll opening of 18-82 in. is available. The vertical rolls are connected to their drive by easily detachable couplings, so that roll changing is a simple matter.

On both sides of the mill are movable side guards, operated through racks and pinions and driven by four

The 45 in. x 80 in. universal slabbing mill is equipped with roller bearings on the horizontal roll necks. This mill produces slabs up to 22 in. in thickness and 67 in. in width, and rolls at rates averaging 230 tons per hour.



Layout of the 45 in. x 80 in. universal slabbing mill at Homestead.



150 hp d-c motors operating under adjustable voltage control. On the delivery side of the mill, the side guard on the drive side is equipped with manipulator lifting fingers, operated by a 150 hp d-c motor.

The mill table on each side of the mill is driven by two 150 hp d-c motors with adjustable voltage control. These tables may be operated at any desired speed up to 930 fpm.

Five circulating systems, ranging 800-10,000 gal in storage capacity and 80-200 gpm in rate of circulation, provide oil lubrication, while grease is supplied to almost 1200 points by 14 motor-operated pressure systems and 3 hand pumps.

A motor-operated rig is installed for changing rolls. The entire roll assembly, including top and bottom bearings and chocks, is removed simultaneously.

One 75/25 ton crane is installed in the mill building for general use.

The 45 in. mill produces slabs ranging 3–22 in. in thickness and 19–67 in. in width, at rates averaging 230 tons per hr. Record productions stand at 3702 tons per 8 hr turn, 9706 tons per day, and 159,792 tons per month.

45 IN. MILL MOTOR ROOM

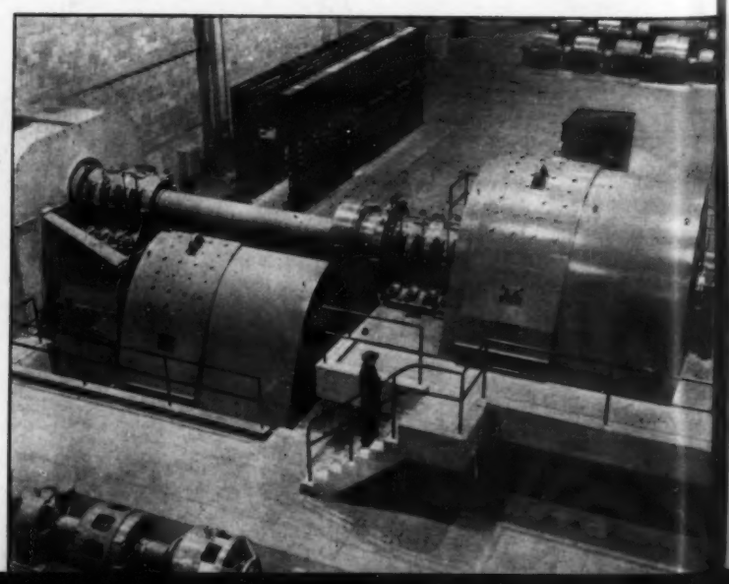
Direct current power for the mill drives is supplied from a motor-generator set consisting of three 3500 kw, 700 volt generators driven at 352 rpm by a 7500 hp, 6600 volt, 25 cycle would rotor induction motor and carrying a 200,000 lb, 15 ft diameter steel plate flywheel. The three reversing motors and the three main generators are all paralleled on a common bus, but equalizing cross connections between generators are arranged so that any generator can be cut out in an emergency. Also, the 3000 hp edging roll motor can be disconnected from the bus if it is desired to use only the horizontal rolls.

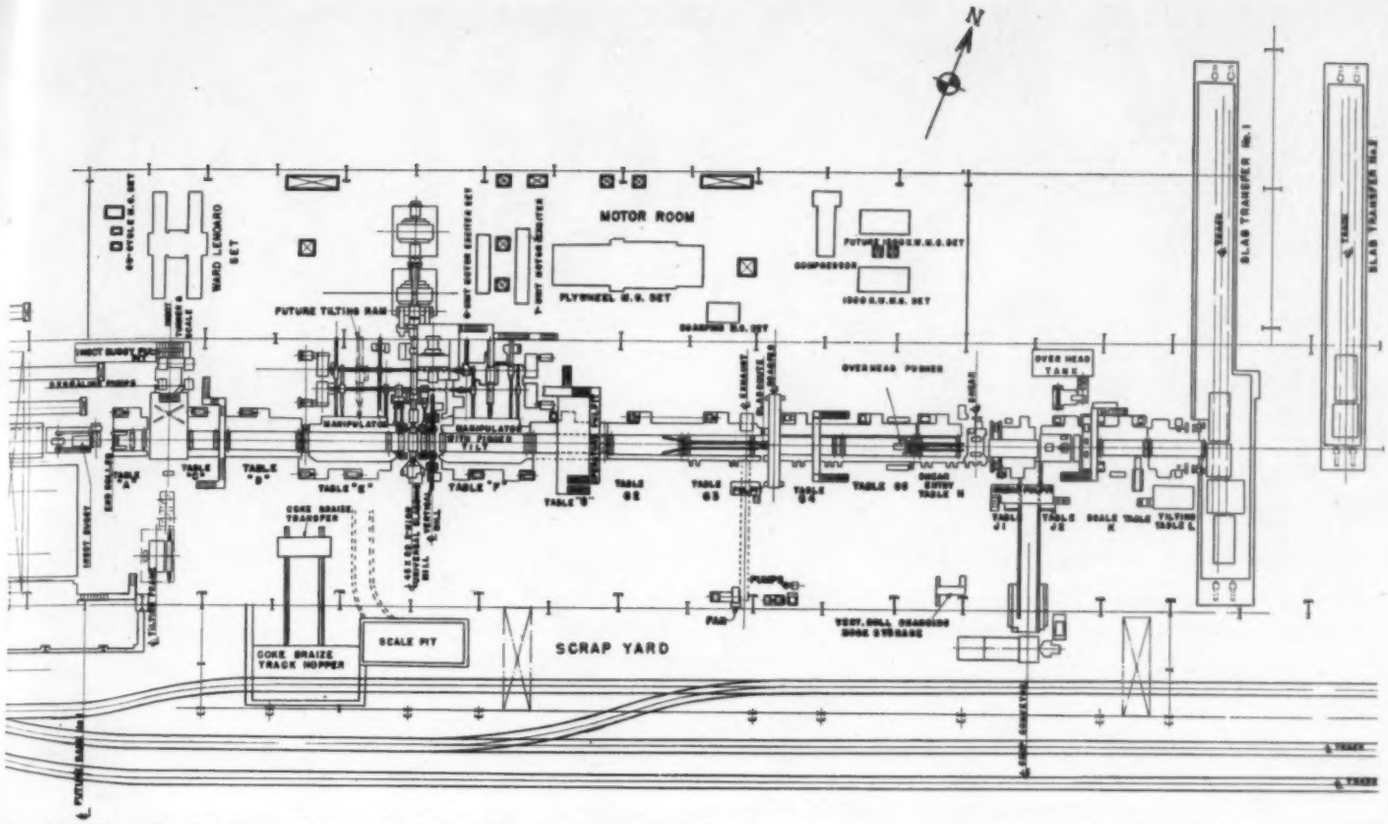
Motor-operated rheostats, controlled from the mill pulpit, adjust the relative speeds of the two 5000 hp motors, as well as that of the 3000 hp motor on the vertical rolls.

Reversal is rapid, the mill going from base speed in one direction to base speed in the other direction in three seconds.

The flywheel set is located in the motor room, which is 65 ft wide and 700 ft long and served by one 60/10

Two duplicate 5000 hp motors, arranged in a twin drive, are connected directly to the horizontal rolls of the slabbing mill. A maximum rolling speed of 940 fpm is available.





ton crane. Here are also located a 1500 kw motor-generator set for general auxiliary d-c power and two motor-generator sets which supply power for the auxiliaries operating under adjustable voltage control. Each of these latter units consists of three 150 kw generators and three 200 kw generators, all 250-500 volt d-c, and all driven by a 1250 hp, 6600 volt, 25 cycle, 750 rpm synchronous motor.

Three 1500 kva, 6600/440 volt, 25 cycle single phase transformers, connected delta-delta, supply power for a-c auxiliary drives.

Motor room equipment is cooled by a closed recirculating ventilating system containing six surface-type air coolers and the necessary fans to insure complete ventilation of all major equipment in the motor room. Make-up air for the system is drawn in from outside through electro-static precipitators.

The slabbing mill and its auxiliaries use 105 motors totaling 21,675 hp. Three of these are main drive units and total 13,000 hp; 16 motors totaling 2010 hp are on auxiliary drives under adjustable voltage control; 44 other d-c motors on magnetic control, equivalent to 2475 hp, drive other auxiliaries; and 42 a-c motors, aggregating 4190 hp, drive pumps, fans, compressors, etc.

Power consumption for the mill averages 10.1 kwhr per ton on the main drives and 12.9 kwhr per ton for auxiliaries.

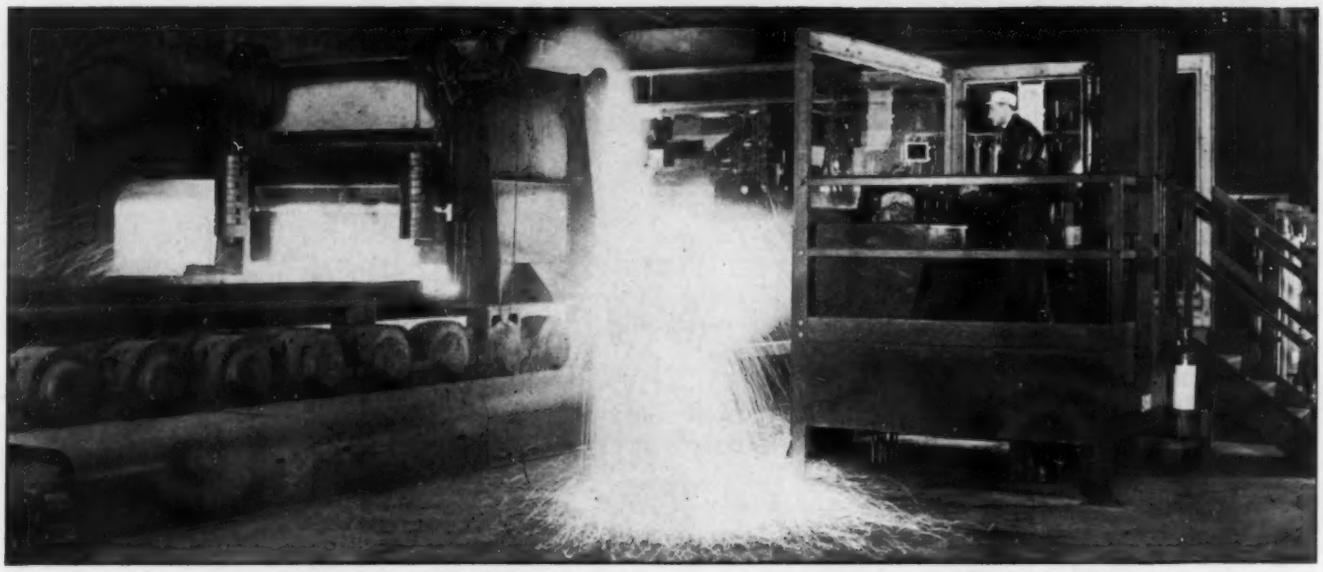
DESCALING

Descaling of the ingot is accomplished by giving the ingot an initial pass on edge to break the scale loose. Removal is then completed by the action of high-pressure sprays, top and bottom, on the entry side of the mill. Two 5 in. 6-stage centrifugal pumps, rated at 800 gpm, 1060 psi, supply water to these sprays.

Mill scale disposal is effected by an unusual combination of wet and dry methods. A concrete flume 2 ft wide at the top and 2 ft deep, and lined with 1 in. welded steel plate, runs under the mill tables from the ingot receiving table to the slab shear. The flume slopes downward at grades of $5\frac{3}{4}$ to $8\frac{1}{3}$ per cent from each end to a low point near the mill, where they converge and continue to a scale pit outside of the building. This pit can hold up to 150 tons or more of scale, and is emptied by a $1\frac{1}{2}$ cu yd grab bucket on an overhead crane. Normally, water flows from the pit by gravity, but a 6000 gpm sump pump is installed to move the when the river is at flood stage. Between 4500 and 5000 gpm of water, all previously used in other equipment, are used to flush the scale through the flume, with flow velocities of 17–21 ft per sec. Where heavy scale may drop, a grid composed of 5 in. × 2 in. billets, set on 8 in. centers, is built over the top of the flume. Heavy pieces of scale fall on these grids and shatter, the small pieces falling between the bars into the flume. Large pieces of scale remain on the grid and are manually scraped into collection boxes carried on a monorail system installed in a passageway paralleling the flume under the mill. These boxes are then dumped directly into charging boxes lowered through a well in the mill floor.

SCARFING AND SHEARING

Following the mill at a distance of about 135 ft is a scarfing machine designed to skin the vertical edges of hot slabs $\frac{3}{8}$ in. thick. In this machine, two similar



Vertical edges of slabs ⅜ in. thick may be skinned in this hot scarfing machine, located in the slabbing mill runout table. Scarfing speed is normally about 100 fpm.

cutting units are carried on independent motor-driven carriages. The number of scarfing nozzles used on each side may range from 3 to 7, as set by the operator through a selector switch on the control board. This board also carries all controls for the scarfing machine, as well as a tachometer showing speed of material passing through the machine. A fairly smooth scarfed surface is obtained with a speed of 100 fpm and oxygen pressures up to 45 psi.

Control of table speed through the scarfer is obtained through use of a bucking generator of 300 kw capacity with a range of 180 volts. The regular 250 volt d-c is bucked down to such value as will give the desired table speed. When the scarfer is not in use, the delivery tables operate at about 400 fpm.

Approximately 65 ft beyond the scarfing machine is the slab shear, a hydraulically operated upcut unit capable of cutting sections up to 20 in. × 62 in. Maximum opening between knives is 27 in., and the top knife head is adjustable by a motor-operated screw, so that the knife opening may be adjusted to suit slab thickness. The bottom shear knife is moved upward for the cutting stroke by a cylinder and plunger 40 in. in diameter. Three horizontal duplex plunger pumps, each rated at 317 gpm, 4500 psi, provide hydraulic power. One, two or three pumps may be used, as the operator desires. Two pumps are adequate to operate the shear at its maximum capacity. A limit switch is arranged to unload the pumps when the shear knives have overlapped about ½ in., and a cam-operated pilot valve performs the same function should the limit switch fail.

Another hydraulic system operating at 1000 psi provides power for balancing the top knife head, pulling back the bottom knife head, and holding down the slab while shearing.

On the delivery side of the shear is a motor-operated shear gage which will handle lengths of 16–20 ft.

Crops from the shear drop through an opening formed by a pullback table on the delivery side of the shear, and are chuted to a flight conveyor which carries them out of the mill building to the scrap yard. Crops are then loaded by crane tongs directly into open hearth charging boxes.

From the shear, slabs pass over a table containing a suspension type bridge scale which may be raised above the top of the table rollers so as to weigh the slab, and proceed to a piler consisting of a hydraulically operated tilting table from which slabs may be run directly on to a motor-driven transfer car. Table height is adjusted for each successive slab until a pile is completed. The delivery end of this table will lift through a 5 ft range. There are two of these cars located on the same track directly at the end of the tilting table, one car being longer than the other and used only for exceptionally long slabs. There is a third car on another parallel track, to which slabs may be moved by crane.

The slab transfer cars connect into two bays of slab storage, each approximately 100 ft wide and 675 ft long. Parts of these yards are not roofed, so as to permit escape of heat and steam from the hot slabs. Each yard has a slab conditioning area served by 16 scarfing outlets and 10-ton gantry cranes. Two 30/15 ton overhead cranes are also provided in each yard. Some additional slab storage and scarfing area is provided by the extension of the slabbing mill building. Slow cooling and preheating pits are installed in all three storage yards. Total storage capacity of the three yards is about 100,000 tons.

After slabs have been conditioned and inspected, they are moved into another storage yard 108 ft × 468 ft which serves the 160 in. plate mill. This yard also contains six gas-fired preheating pits, each capable of heating about 10 slabs up to 1200 F in 24 hours, as well as three gas-fired preheating hoods, each capable of heating 120 tons of slabs to 1600 F in 24 hours. From this yard slabs are served to the plate mill furnaces by

This hydraulically operated upcut shear is designed to cut sections up to 20 in. x 62 in. Its motor-operated shear gage handles lengths of 16-20 ft.

standard gage shuttle car transfers hauled by 25 ton diesel locomotives.

PLATE MILL FURNACES

Heating facilities in the plate mill consist of two continuous furnaces and two batch type furnaces. This combination of furnaces has worked very satisfactorily, permitting the rolling of plates from relatively long, thin slabs, which means reduced heating time and fewer passes in the mill, while at the same time the batch furnaces provide means of heating small lots of special grades of steel that may require various temperatures.

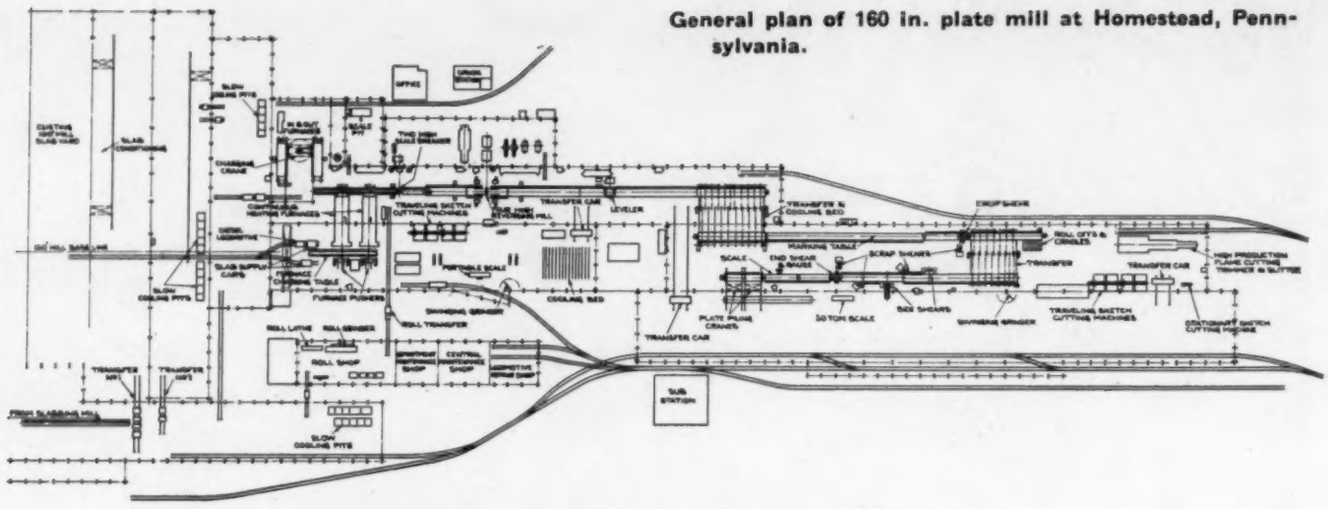
The continuous furnaces are of the three-zoned, recuperative type, end charged and end discharged. They are 23 ft wide, with an effective hearth length of 80 ft, and are rated at 70 tons of cold steel per hour each. A mixture of natural and coke oven gas, averaging 600 Btu per cu ft, is normally used in all three firing zones; but the two main firing zones may be switched to fuel oil. Temperature control is provided in the soaking zone of these furnaces as well as in the heating section. Furnace pressure and fuel-air ratio are also automatically controlled.

Slabs ranging 70–120 in. in length, 3–12 in. in thickness, and up to 66 in. in width, and 23,000 lb in weight are heated in these furnaces. The slabs are moved from the transfer car to the furnace charging table by overhead crane with magnets or tongs. Double rack type pushers move the slabs through the furnaces in two rows.

The two batch type recuperative furnaces heat slabs up to 144 in. × 55 in. × 20½ in., weighing as much as 43,500 lb. They are fired at each end with a mixture of natural and coke oven gas, with two-zone temperature control. Effective hearth dimensions are 46 ft × 12 ft, and each furnace has a rated capacity of 15 tons of cold steel per hr. Each furnace has two doors, each door having three sections, which act independently. Either half of the furnace may be opened free of door jambs, or the entire furnace front may be opened with only one jamb.

These in-and-out furnaces are charged and drawn by

A stiff-leg swivel crane serves the two batch type heating furnaces at the plate mill. A combination of batch and continuous furnaces provide great flexibility in heating for this mill.



General plan of 160 in. plate mill at Homestead, Pennsylvania.

a stiff-leg swivel crane which runs between the two furnaces.

Fuel consumption of all furnaces averages about 2,500,000 Btu per ton of steel heated.

160 IN. PLATE MILL

The first unit of the mill is a two-high scalebreaker driven through a double reduction flywheel gear drive, universal lead spindle, pinions and universal mill spindles by a 1600 hp, 6600 volt, 3 phase, 25 cycle, 492 rpm wound rotor induction motor. The reduction gear has a ratio of 15.68:1, giving a roll speed of 31.5 rpm, and a surface speed of 296 fpm. The rolls in this unit are 36 in. in diameter × 70 in. body length, and are knurled so as to break up scale more effectually. Descaling is completed through the action of 1500 psi hycraulic sprays located top and bottom on the delivery of the scale breaker stand. The rolls operate in composition bearings which are lubricated by water with a shot of soluble oil added every 20 minutes by an automatic timing device. The top roll is balanced by carrier bars supported by a yoke actuated by hydraulic jacks.

Mill spindles 19 in. in diameter and 23 ft long connect the mill rolls to the mill pinions. The pinions are 38 in. in diameter with 48 in. face, and contain 24 teeth of 4.974 in. circular pitch.

Mill screws which are 12 in. in diameter and ½ in. pitch, are driven by a single 50 hp d-c mill type motor, with a roll lift speed of 11 in. per min. Roll opening, which has a maximum limit of 22 in., is indicated in the pulpit by a selsyn unit. Twin adjustable side guides, designed for a maximum opening of 68 in., are provided on both sides of the mill.

Following the scale breaker there is a turn-table with hydraulic lift and motor-driven turning mechanism, by which slabs may be turned through 90 degrees for cross-rolling.

Located 160 ft from the scale breaker is a four-high plate mill. Work rolls in this unit are 38 in. in diameter × 160 in. body length, and have necks 27 in. in diameter running in four-row roller bearings. Back-up rolls are 59 in. × 154 in. and have 33 in. necks running in oil film bearings. Two-row steep-angle roller bearings absorb the thrust. Top rolls are balanced hydraulically, under a pressure of 3700 psi. Work rolls are changed with a C-hook having a motor-operated shift to change the center of gravity of the lift. Back-up rolls are moved in and out on a motor-driven slide.

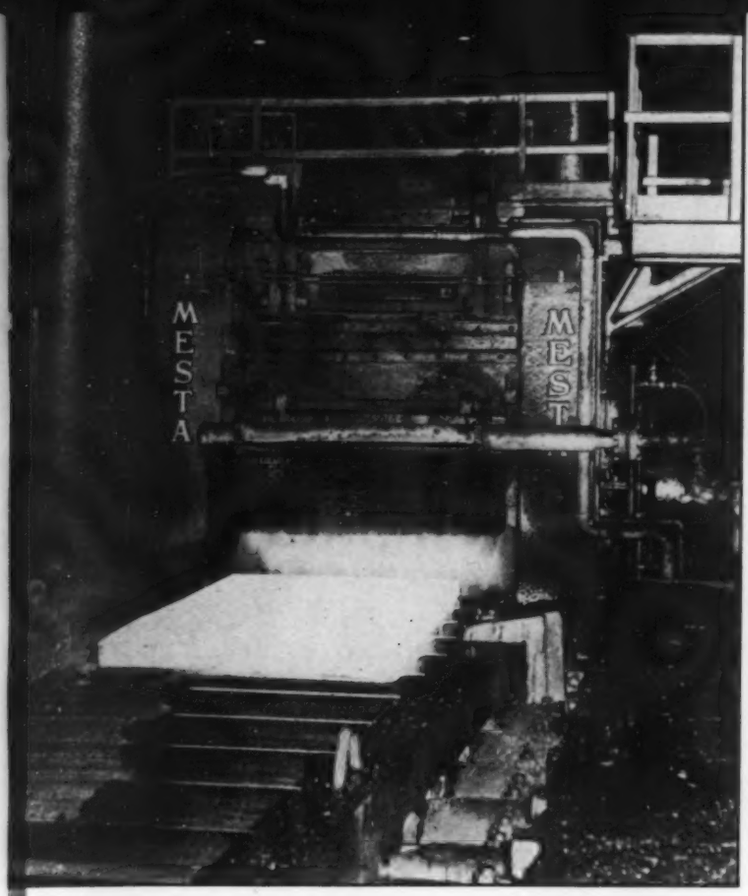
This mill is driven by a twin-drive arrangement, using two 5000 hp, 700 volt, 40-80 rpm d-c motors. This is the first application of this type of drive to a plate mill. The two motors, which are connected directly to the mill rolls by universal spindles 36 ft long, have combined torques at 40 rpm of 1,312,000 lb-ft continuous rated load, and 2,953,000 lb-ft maximum. Roll surface speed is 400-800 fpm. The motors are connected to the rolls by universal mill spindles 21 in. in diameter and 36 ft long.

The main drive motors receive power from a motor-generator set consisting of three 3000 kw, 700 volt d-c generators driven by a 9000 hp, 6600 volt, 3 phase, 25 cycle, 375 rpm wound rotor induction motor. The flywheel on this set stores up 245,000 hp-sec at 375 rpm.

Mill screws are 18 in. in diameter with 1 in. pitch. They are operated by two 150 hp d-c motors operating under variable voltage. A maximum roll lifting speed of 50 in. per min may be attained, and a maximum lift of 20 in. is available. Screwdown operation may be controlled manually or by a preset automatic two-schedule, 13-pass control. One automatic rolling schedule may be set up while the other is operating. When desired, the operator can interrupt the automatic schedule and adjust the screwdown setting without affecting subsequent automatic settings.

Hydraulic descaling sprays, operating at 1475 psi, are also installed, top and bottom, on the delivery side of this stand. Additional sprays, operating at 150 psi, provide cooling for the rolls.

Front and back mill tables are 33 ft long, and are each driven by four 50 hp mill type d-c motors, under variable voltage control. Slabs may be turned around on the front or back mill tables through the action of the table rollers, which are alternately tapered in opposite direction, with alternate rollers on separate motor drives. Movable side guards are installed on each side of the mill to manipulate the slabs. Mill approach and



Knurled rolls in the plate mill scale breaker, in conjunction with hydraulic sprays, effectively remove scale from the hot slabs. The scale breaker is driven by a 1600 hp induction motor.

runout tables are also driven by d-c motors under variable voltage control. Power for table drives and for the mill screwdown motors is provided by two motor-generator sets, each consisting of two 150 kw and two 200 kw 250 volt d-c generators driven by an 800 hp, 6600 volt, 3 phase, 25 cycle, 750 rpm synchronous motor.

All main drives, motor-generator sets and switchgear are located in a motor room, 85 ft × 312 ft, adjacent to the mill building. A 60/10 ton crane is installed here.

Seven major oil systems, ranging 550-15,000 gal storage capacity, provide lubrication for table line shafts, gears and bearings, roller leveler, screwdown, reduction gears, mill pinions, back-up roll bearings, etc.

Eleven major automatic single line reversing pressure systems supply grease to lubricate table bearings, spindles, spindle carriers, hydraulic jacks, etc. Hand pump systems are provided where automatic systems are not feasible.

The plate mill building is 100 ft wide × 936 ft long, and is served by two overhead cranes, one of 100 tons and one of 35 tons capacity.

The plate mill rolls slabs ranging up to 144 in. long, 60 in. wide and 20½ in. thick into a wide range of plate sizes. Sheared plate is produced in lengths up to 720 in. with widths ranging 38–144 in. and gage 31/6–1½ in. Flame cut plate is produced in thicknesses of 1½–15 in. with lengths up to 480 in. and widths up to 144 in. The mill maintains an average rolling rate of about 90 tons per hr, and has set records of 1254 tons per 8 hr turn, 3434 tons per day, and 52,042 tons per month. Power consumption averages 24.2 kwhr per ton for main drives and 52.6 kwhr per ton for auxiliaries.

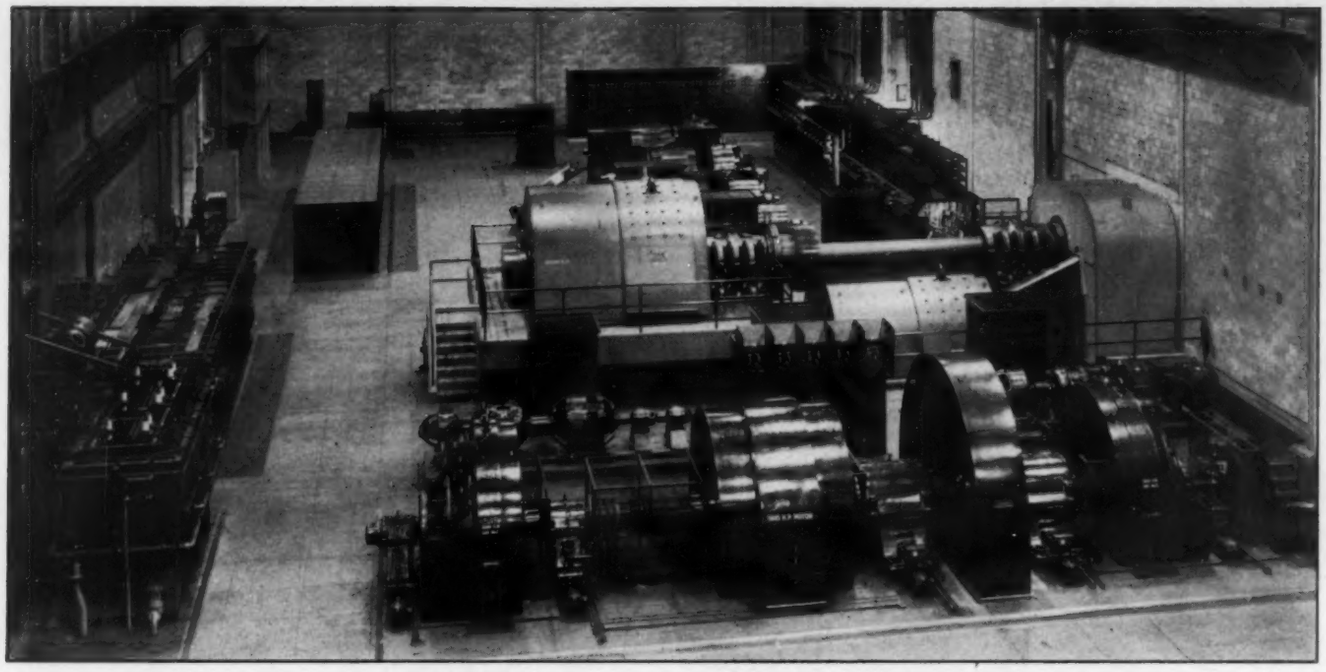
As the plates leave the four-high mill, they pass through cooling sprays placed top and bottom along the table for a distance of 180 ft. This accelerated cooling reduces secondary scale formation and also brings plate temperature to the proper point for leveling in the hot leveler. This unit is a two-high leveler located 216 ft from the four-high mill, with rolls 16 in. in diameter × 160 in. long, and is designed to level plates up to 1 in. thick at 1200 F. This machine has a maximum roll lift of 6 in. To insure uniformity in the leveling operation, drum indicators are provided at all four corners of the leveler housing.

Before and after the leveler a section of runout table is arranged so that heavy plates may be lifted from the table by crane and C-hooks, and loaded on to either of two motor-driven transfer cars. One of these cars connects into an adjacent bay where flame cutting equipment is installed, while the other connects into the shipping building.

SHEARING AND FLAME CUTTING

Plates not lifted off the table at the leveler pass on to a chain and grid cooling bed, 120 ft wide × 108 ft long, over which they are transferred to the marking table, 292 ft long, in the shear building. Along a 140 ft section of this table there is a motor-driven automatic measuring machine which travels at a maximum speed of 215 fpm. Indexed longitudinal and transverse movements on this machine enable the operator to measure

The 160 in. plate mill produces a wide range of plate sizes, ranging from 3/16 in. to 15 in. in thickness. An average rolling rate of 90 tons per hour is maintained.



A twin drive of two 5000 hp motors directly connected to the rolls is used on the plate mill. This is the first application of this type of drive to a plate mill.

and mark off the desired size of rectangular plate, and to scribe a reference line to guide the side-shear operator.

A crop shear is installed in the marking table, designed to cut maximum width plate up to 1½ in. thick. Of down-cut guillotine type, this shear has 160 in. blades with a rake of ½ in. per ft. It is operated by oil-hydraulic pressure at 7000-9000 psi. Two hydraulic cylinders and plungers exert pressure, one at each end of the shear ram. Equal hydraulic displacement in these cylinders produces a vertical movement of the ram, which carries the upper knife. Movement of each plunger is maintained equal by the stroke of a duplex pump which has each of its twin cylinders piped separately to one of the hydraulic cylinders in the shear. Oil-hydraulic hold-down gags, operating under 1700 psi pressure, effectively clamp the plate during the shearing operation.

This shear is used for dividing plates too long for subsequent transfers, as well as for finish shearing the front end, and sometimes both ends.

From the crop shear the plate may pass on to a roll-off and piling cradle, or it may be diverted across a 68 ft × 84 ft chain transfer to the shear table, which doubles back in the direction of the mill. This table contains three shears, two side shears with 180 in. knives and one end shear with 160 in. knives. These shears are of the same type and operate on the same principle as the crop shear previously described. The side shears are on opposite sides of the table, and are 78 ft apart, while the end shear is 84 ft beyond the second side shear.

At the shears, plates are aligned or skewed as desired through the action of a series of electromagnets located in groups of four beneath the table line between the rollers. There are eight magnets in front of each side shear. The magnets are moved across the table by motor-driven screws, and they may be elevated a short distance above the top of the table rollers by eccentric cams and double acting hydraulic cylinders. A mechanical width gage with dial indicator is provided at the second side shear to facilitate lining up the plate before trimming the second side.

The end shear is equipped with squaring pushers on the entry side and a motor-operated shear gage on the delivery side. Lengths ranging 60-720 in. can be mechanically gaged.

Scrap shears are provided at each of the four shearing units of this mill. The scrap is collected in buckets from gravity chutes from the shears.

The shearing completed, plates pass over a scale table, where they are individually weighed, and on to a table covered by two 12-ton transverse piling cranes. Using electromagnets, these cranes transfer plates, one at a time, into the adjacent shipping building. One crane can handle plates up to 30 ft long, while the two cranes operating together can handle lengths up to 60 ft. The piling cranes have sufficient lift to permit inspection of the bottom sides of the plates at this point.

Extensive flame cutting facilities have been provided. Immediately adjacent to the mill, and connected to it by a previously-mentioned transfer car, is a building 110 ft wide × 375 ft long, served by two 30-ton cranes which operate on the runway carrying the continuous heating furnace charging crane. Here are installed three pantograph sketch cutting machines of traveling and stationary types. These units are used primarily for intricate shape cutting, and employ a magnetic tracing mechanism traveling over templates (or operated manually over sketches) to guide the torches through the desired course. Also provided are cooling skids, a heat treating pit, and two large heat treating ovens, used variously for preheating, normalizing, stress relieving and controlled cooling, as desired. The ovens

may also be used to preheat slabs of special analyses, prior to charging them in the slab heating furnaces.

Additional flame cutting equipment is installed in the end of the shear building, where three pantograph units, duplicating those previously mentioned, are installed. There is also a flame planer, in which plates may be side trimmed, end trimmed or slit simultaneously by flame cutting machines mounted on motor-driven carriages traveling along rails over a motor-driven conveyor table about 40 ft long.

Circular plates 3/16–15 in. thick may be flame cut in diameters up to 146 in.

The shipping building is 125 ft × 1092 ft and is served by four 30-ton cranes of double-hoist type. A single railroad track, capable of accommodating 22 cars, runs the entire length of the building, and is connected by cross-overs to a parallel track in an adjacent lean-to, where 8 cars can be accommodated. Besides the piling cranes, the shipping building has two other inlets, the previously mentioned transfer car from the mill runout table, and another transfer car from the end of the shear building, where part of the flame cutting equipment is installed. Some controlled cooling hoods are provided in the shipping building for heavy plates coming direct from the mill.

FORGING AND HEAT TREATING DEPARTMENT

Another unit in the expansion program is a large forging and heat treating department, built for the production of some items of armament as well as large gears, rolls and other commercial forgings.

Heating facilities here consist of the following:

1. Two 12 ft × 30 ft car bottom forging furnaces, fired top and bottom by either oil or gas as desired, of 300 tons live load capacity.
2. Seven 15 ft × 49 ft car bottom forging and treating furnaces, fired top and bottom by oil or gas as desired, of 500 tons live load capacity.
3. Six 10 ft × 40 ft car bottom treating furnaces, underfired by gas, of 300 tons live load capacity.

The first and second types listed above have 18 in. walls of five clay brick, and sprung arch roofs of 12 in. of firebrick plus 2½ in. of insulation. Type 3 furnaces have sidewalls of 13½ in. of firebrick plus 2 in. of insulation below the hearth level, and 13½ in. of insulating firebrick plus 2 in. of insulation above the hearth. The roofs are sprung arches of 12 in. of insulating firebrick plus 2½ in. of insulation. The car bottoms of these treating furnaces are insulated.

The cars which form the bottoms of these furnaces have a heavy structural frame, and move on 20 in. rolled steel, double-flanged wheels which are protected against the heat. Car hauls are of sprocket chain type, operated by motors at a speed of 40 fpm.

Fuel oil is bunker C grade, supplied at about 50 psi and atomized by steam. Gaseous fuel is a mixture of coke oven and natural gas averaging about 600 Btu per cu ft.

The forging furnaces are designed to heat steel to a temperature of 2300 F, and to hold a minimum sus-

This plate mill crop shear is operated by oil-hydraulic pressure at 7000-9000 psi pressure, and is designed to cut plates up to 1½ in. in thickness.

Forging is done in a 7000 ton hydro-pneumatic press operating under 4500 psi pressure. Stock is handled by a floor manipulator or by a 300-ton hydro-electric overhead crane.

tained temperature of 1100 F. Treating furnaces are designed to heat stock to any desired temperature with the range of 400–1800 F.

Stock heated in these furnaces consists of 250 ton ingots 6 ft × 13 ft in cross section and 175 ton ingots 96 in. in diameter. Heating cycles range from 8 hr to 14 days as required by the size and analysis of the stock.

Three small tanks and one large tank contain oil for quenching after heat treating. The tanks are heated by gas to maintain oil at the desired temperature.

The forging press is a four-column hydro-pneumatic unit rated at 7000 net tons, and standing more than 43 ft above the floor. Columns are 26 in. in diameter, made of forged steel and spaced on centers of 18 ft 6 in. and 7 ft 4 in. The two main cylinders are 43 in. in diameter and operate under pressures up to 4500 psi. The plungers have a stroke 10 ft long, and move at a speed of 3 in. per sec on the working stroke and 10 in. per sec on the idle stroke.

The press is powered by three horizontal double-acting pumps, each rated at 330 gpm and 4500 psi, and driven by a 1000 hp motor. Four hydraulic-pneumatic accumulators, constructed of multi-layer plate steel and having a capacity of 2250 gal each, are installed in the system. A horizontal two-stage air compressor, of 16 cfm capacity at pressures of 90–4500 psi, supplies make-up air to the accumulators. A low pressure prefill air compressor and a prefill water pump are provided.

An automatic pressure system provides grease lubrication to various points of the press, and oil is supplied to the guide for the crosshead from a motor-operated oiling system.

While forging, stock is handled by a 300-ton floor-operated hydro-electric crane and by a motor-driven manipulator. A 125/25 ton overhead crane, operating crosswise in the forge shop, provides press service.

The forging and heat treating equipment is installed in two adjacent bays 107 ft wide × 644 ft long, each bay containing one 300-ton floor-operated crane, as previously mentioned, and one 200/25 ton crane. A 55 ft lean-to runs along each side of these buildings. One transfer track runs between the two bays of the forge shop, near the press. Another transfer track runs between the two forge shop bays and on into the machine shop. The machine shop, which is 106 ft wide × 690 ft long, parallels the other buildings. Two 75/15 ton cranes are installed here, and a 2-ton crane is located in the machine shop tool room.

In the machine shop are sixteen large heavy-duty lathes ranging from 48 in. × 30 ft, up to 96 in. × 80 ft, as well as a milling machine, drill press, boring mill, etc. This equipment is used principally for rough turning

large forgings. Cutting oil is supplied to all lathes from a central pumping system. The tool room contains two lathes, a shaper, a milling machine and six grinders.

Three 1500 kw motor-generator sets provide d-c power for equipment in the forging and machine shops.

FACILITIES AT DUQUESNE WORKS

To expand facilities for the production of special steels, three electric arc furnaces were added at the Duquesne works of the company. Two of these have shells 15 ft 8 in. in diameter at the bottom and 18 ft at the top, and accommodate heats of about 95,000 lb. One of these furnaces is provided with a 12,000 kva transformer, while the other is fed from a 15,000 kva unit. Both transformers contain 4.2 per cent reactance and each is equipped with a motor-driven, five-position no-load tap changer. Secondary voltage steps are available at 265, 250, 235 and 220 volts at full capacity, and 205, 190 and 175 volts with reduced capacity. Still lower voltages may be had by changing primary connections from delta to Y. Primary voltage is 22,000.

The third furnace is a 20 ft diameter unit, from which heats of 160,000 lb are tapped. This furnace has a 15,000 kva transformer containing 4.2 per cent reactance. Secondary taps provide voltages of 280, 265, 250 and 235 at full capacity, and 220, 205, 190 and 175 with reduced capacity. As in the case of the smaller units, lower voltages may be had by changing primary connections.

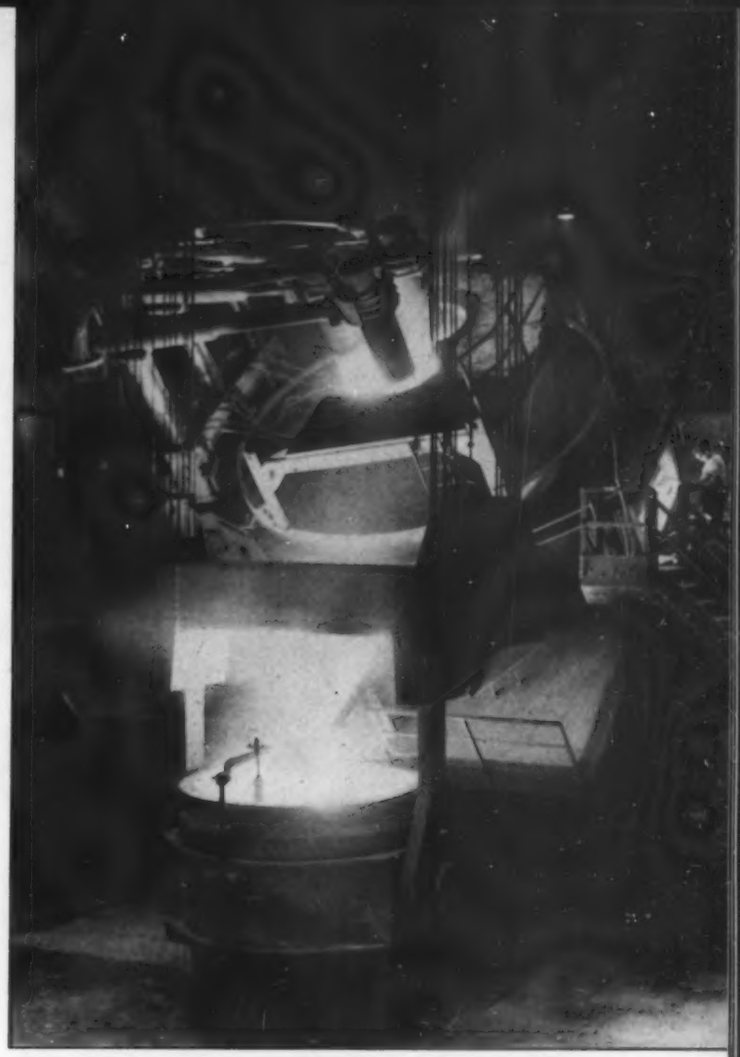
Three 20 in. graphite electrodes are used on each furnace, current being carried to the electrodes by three flexible secondary leads. On the smaller furnaces, each lead is composed of 32 cables of 1,750,000 cir mils each, while the larger furnace has 36 cables of the same size in each lead. A 34.5 kv oil type breaker, having an interrupting capacity of 500,000 amp, is installed on each furnace. Disconnect switches are installed before and after the furnace breaker, and also on the individual furnace feeders at the outdoor substation.

Electrodes on all furnaces are controlled by current regulators of vibrating contactor type.

The furnaces are all of tilting type, operated on a rocker and rack by a d-c motor. Electrode masts are movable, raised and lowered by motor-driven winches.

Furnace linings are basic. Side walls are lined with 13 in. of magnesite brick, and last about 190 heats. Roofs are 13 in. thick, with the first course next to the water-cooled roof ring of first quality fire clay brick, and the remainder of silica brick. Fits are cut with an abrasive saw, and no bond is used. An expansion allowance of $\frac{1}{8}$ in. per ft in both directions is allowed, and is provided by the use of corrugated cardboard. Roof life averages about 60 heats.

Charges consist entirely of cold scrap, about 60 per cent of alloy grade and 40 per cent of ordinary steel. The scrap is put into the furnace by a floor type charging machine. Steel is made in a broad range of analyses, including rimmed steels, open hearth and electric carbon steels, S.A.E. grades, manganese steels, all grades of stainless, and some tool steels. Both single and double slag practices are used, with reducing slags of carbide, lime-silicon, and lime-aluminum types. All deoxidation



Three electric arc furnaces installed at Duquesne works increase facilities for the production of special steels. Almost every type and grade of steel is made in these units.

is performed in the furnace, with ladle additions of shot aluminum for grain control.

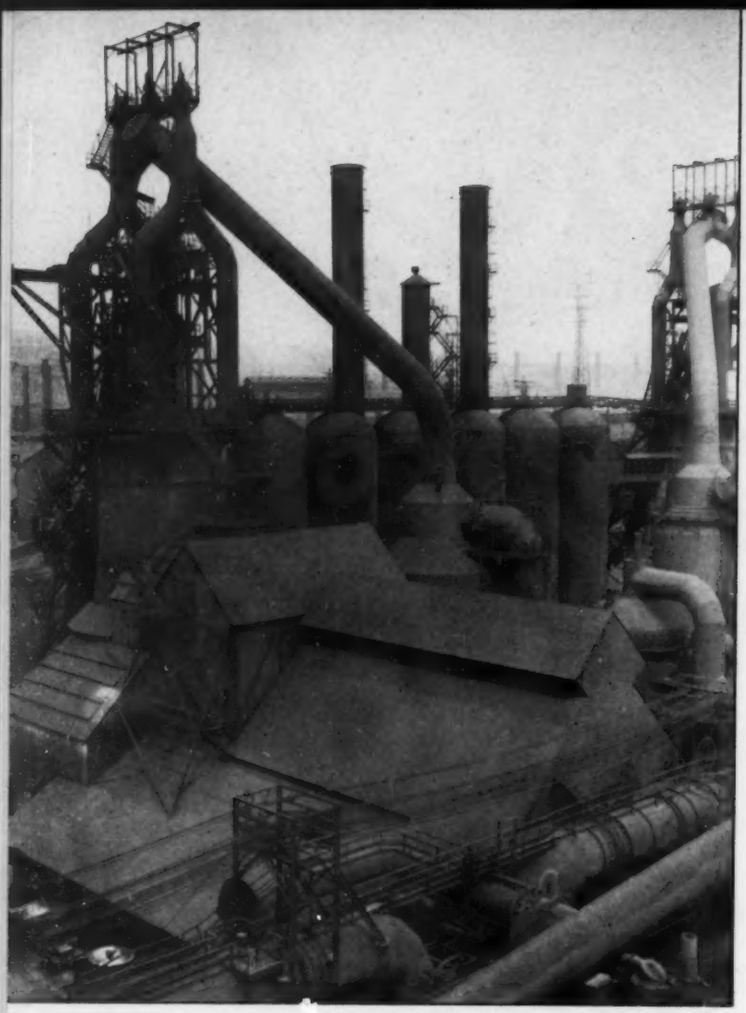
Steel is poured into hot-topped, big-end-up ingots ranging from 19 in. in diameter, 4400 lb weight, to 55 in. in diameter, 95,000 lb weight. Rectangular ingots range from 15 in. × 42 in., 8000 lb, up to 34 in. × 66 in., 53,800 lb.

Average time of heats is 7.95 hr charge to tap, 9.4 hr tap to tap. Power consumption averages 608 kwhr per ton, and an overall power factor of 78 per cent is usually maintained.

The furnaces are installed in a group of buildings which provides a charging floor 80 ft × 450 ft, with a 25 ton crane, a pouring pit 75 ft × 525 ft, with two 125-ton ladle cranes, and a stockyard 82 ft × 450 ft, with two 25-ton cranes.

Raw materials enter the melt shop in gondola, box and container cars. Some small lots are brought in by truck. Storage is principally in bins, but considerable use is made of trucks and pallets for handling and storing materials received in bags, drums, or barrels.

Heat treating facilities at Duquesne works were also expanded. The buildings consist of a 90 ft × 544 ft bay with a 69 ft × 396 ft lean-to and a 90 ft × 230 ft transverse bay. In addition to storage beds, entry and delivery tables, quench tanks, etc., there are three



At Edgar Thomson works, two blast furnaces have been fitted into a compact layout to suit existing space. With hearth diameters of 27 ft 6 in., these furnaces each average 1020 tons of iron per day.

gas-fired 25-ft car bottom furnaces, two gas-fired 36-ft car bottom furnaces, and one 7-chamber continuous electric furnace. Four roller straighteners of various sizes provide straightening for round bars ranging in diameter from ¼ in. to 5½ in. A hydraulic gag press straightens rounds up to 8½ in. Cut-off machines and a centerless grinder are also provided. Material is handled by tractor, transfer buggy and four 25-ton overhead cranes.

BLAST FURNACES AT EDGAR THOMSON WORKS

To balance production facilities in the district, two blast furnaces were constructed at the company's Edgar Thomson works. These units have a hearth diameter of 27 ft 6 in., a bosh diameter of 30 ft 6 in., and a 21 ft stockline. Heights of the various sections of the furnaces are as follows:

	Ft–in.
Hearth section	12–0
Bosh section	9–9
Straight section	11–9
Inwall section	52–9
Stockline section	7–5½

Working volume of the furnace is 44,800 cu ft.

View of firing aisle in the powerhouse, where three 680 psi steam generators are installed. They are fired with blast furnace gas or pulverized coal.

Overall height is 105 ft 5 in. from iron notch to the top of the distributor hopper.

The iron notch is centered 2 ft 6 in. above the furnace bottom. Two cinder notches are provided, located 4 ft 8 in. and 5 ft 2 in. respectively above the iron notch. There are 18 tuyeres, spaced around the furnace 3 ft 4 in. above the higher cinder notch.

The bosh angle is 81 deg, 15 min and 13 sec, and the inwall batter is 1.08 in. in 12. The large bell, which has a 53 deg angle, is 15 ft 5 in. in diameter, leaving an annular space of 2 ft 9½ in.

Furnace lining is 3 ft thick in the hearth, 2 ft 7½ in. thick in the bosh, 3 ft 4½ in. in the stack, and 4 ft 1½ in. in the throat. A total of 801,149 9-in equivalents are represented. The hearth is cooled by water coils cast integrally with the hearth jacket, while copper cooling plates are used through the bosh and up into the stack. Cast iron wearing plates protect the lining at the stockline.

Gas leaves the furnace through four offtakes of 6 ft 9¾ in. inside diameter, spaced 90 degrees apart around the furnace top cone. The four offtakes merge into two uptakes which in turn merge into a single downcomer. All of the gas then passes through a dustcatcher, a wet washer, and an electrical precipitator. The raw gas leaves the furnace top at pressures of approximately 35 in. water column and temperatures of about 290 F. Where gas entering the dustcatcher contains 7.5 grains of dust per cu ft, the dust content is reduced to perhaps 2.5 grains per cu ft in the dustcatcher, then cut to about 0.15 grains per cu ft in the washer, and finally cleaned to 0.008 grains per cu ft in the precipitators. Moisture in the gas is reduced considerably while passing through the wet washer. The clean gas, which has a calorific value averaging about 90 Btu per cu ft, is used in the blast furnace stoves and as boiler fuel. Effluent from the gas washer flows to a thickener which serves both furnaces, where the sludge settles out and is removed. The sludge is generally shipped to another plant to be put through a sintering machine.

The furnaces are blown by two turboblowers, each rated at 90,000 cfm of air under standard conditions at 30 psi pressure. Normal blast volume averages 70,600 cfm, with pressure running about 20 psi at the tuyeres. The blowers are located in the powerhouse, and will be discussed subsequently.

Blast for each furnace is heated by three stoves 25 ft in diameter × 120 ft high. Each stove contains 245,182

sq ft of heating surface provided by brick of special design containing flue openings 1-15/16 in. square. The checkerwork in each stove contains approximately 2,500,000 lb of brick. Each stove contains a total of 662,097—9 in. equivalents.

The stoves are operated on a 4 hr gas cycle, and a 2 hr blast cycle. Gas is introduced through automatic pressure burners, and is completely burned with about 10 per cent excess air. Stack temperatures average about 400 F, although they vary 200 degrees during the gas period.

Blast temperature is normally maintained at 1025 F by automatic control. The stove cycle is regulated so that the mixer valve is fully closed after the stove has been on blast 2 hr. The stoves consume approximately 19 per cent of the blast furnace gas, and another 5 per cent is lost by leakage and bleeding.

The two new furnaces are served by previously existing ore storage and unloading facilities, and share a high-line common to other furnaces in the plant.

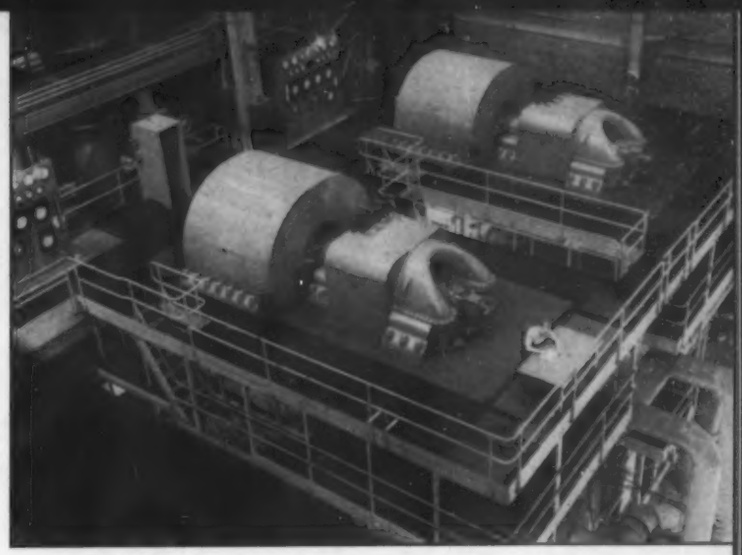
The furnace is burdened with a mixture of low and high silicon ores which averages 50.73 per cent Fe, and 0.674 per cent Mn, 0.6 per cent P, 6.82 per cent SiO_2, and 1.65 Al_2O_3, with traces of CaO, MgO and S. About 80 per cent of the ore will pass through a 20 mesh screen. No ore grading or crushing is practiced.

Coke comes from the by-product coke plant of the company's Clairton works, and is unloaded directly into the furnace bins. It contains about 12 per cent ash and one per cent sulphur. In the furnace stockhouse, stationary screens remove all coke smaller than ¾ in. from the charge. Approximately 60 per cent of the coke is larger than 2 in. Coke consumption averages about 2000 lb per gross ton of iron produced.

Limestone, sized through a 3 in. screen and over a ½ in. screen, contains an average of 51.8 per cent CaO.

Miscellaneous materials charged per gross ton of iron include 353 lb of open hearth slag, 41 lb of roll scale and 145 lb of open hearth cinder.

The furnace burden shows a normal ore-to-coke ratio of about 2.225, and contains 935 lb of limestone per gross ton of iron, and 7.25 per cent SiO_2. Ore and limestone is measured by weight, while coke may be measured by weight or volume as desired. The furnace is charged by the conventional double skip, small bell, revolving distributor and large bell. A charging cycle of OCSOCC is followed.



Blast for the furnaces comes from two 90,000 cfm turbo-blowers located in the powerhouse.

Each furnace produces an average of 1020 tons of iron per day, principally in two grades analyzing as follows:

	Basic iron	Ingot mold iron
Silicon	1.16	1.50
Sulphur	0.029	0.029
Phosphorus	0.235	0.134
Manganese	1.65	1.27

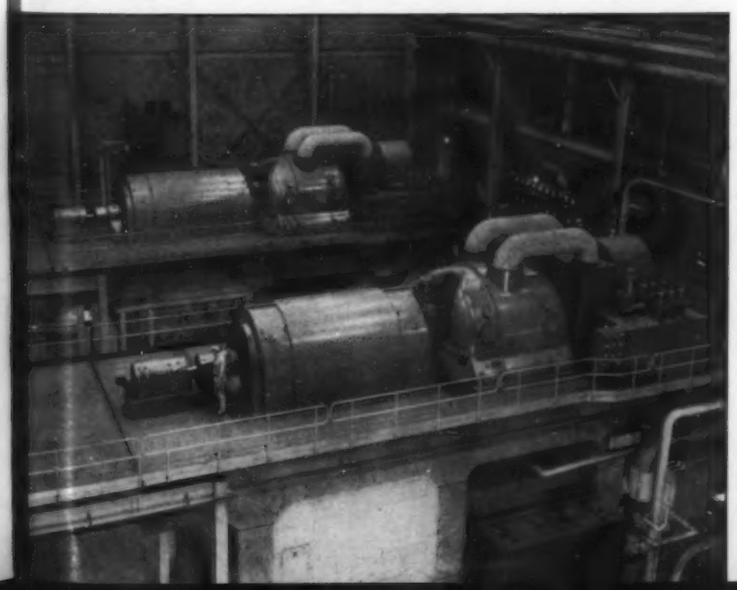
Iron is tapped five times in 24 hr into ladle cars which are then moved by rail to the open hearth shop or to the foundry.

Slag is tapped into ladles and hauled to a large dump which serves other furnaces in the district. Approximately 1200 lb of slag is produced per ton of iron, analyzing approximately as follows:

	Per cent
SiO_2	35.9
Al_2O_3	12.8
CaO	43.6
MgO	4.9
S	1.8
Mn	2.5
Fe	0.25

Flue dust averages about 225 lb per ton of iron produced.

Two 31,250 kva turbogenerators produce power at 13,800 volts, 60 cycles, for use in the networks which serve the company's plants in the Pittsburgh district.



POWERHOUSE

To expand power production to supply the new facilities at the company's Homestead and Duquesne works, a new power station was installed at Edgar Thomson works. This station contains three 3-drum steam generators, complete with economizers and air heaters, designed to operate at 680 psi, 750 F temperature. The superheaters contain a radiant section as well as a convection section, with automatically controlled by-pass dampers to maintain constant steam temperature.

The boilers are fired with blast furnace gas or pulverized coal, and are designed to produce 286,000 lb of steam per hr on gas, while pulverizer capacity limits the production on coal to 192,000 lb of steam per hr.

Ten vertical pumps, centrally located in one pumphouse, provide water for the powerhouse and general service. Water, taken from the Monongahela River, is screened and treated with lime.

Trial runs using gas and coal simultaneously have attained production rates of 325,000 lb of steam per hr, with short peaks up to 350,000 lb per hr. Two induced draft fans and two forced draft fans, all turbine driven, are installed for each boiler.

Combustion and feedwater controls are air-operated and conventional in application, with boiler loading actuated from station steam pressure and dampers automatically controlled. Boiler efficiencies of 82-84 per cent are maintained. Blast furnace gas pressure is tied into the control system so that if gas pressure drops a predetermined point, pulverized coal starts to feed to the coal burners and butterfly valves in the gas lines to the boilers begin to close.

Coal is unloaded into a track pit, hoisted by skip to a receiving hopper, and passed through a crusher of 100 tons per hr capacity. A belt conveyor then carries the coal to three 200-ton bunkers, which feed through scales to feeders to the unit pulverizers. One pulverizer of 10 tons per hr capacity, feeds each boiler through three burners.

Ash and dust is handled by a pneumatic ash removal system which discharges into a tile silo. The silo is unloaded through a pug mill into hopper cars.

Feedwater is supplied from four centrifugal pumps, two driven by turbines and two by motors, thus providing protection of operations as well as a means of maintaining the exhaust steam balance. The exhaust steam from the various station auxiliaries is used to heat the feedwater in a 900,000 lb per hr deaerating feedwater heater.

Steam is distributed through the station by a single pipe system with two main headers, so arranged that the system can be sectionalized to protect operations under almost any eventuality.

Power is generated at 13,800 volts, 60 cycles by two 31,250 kva turbogenerators. The turbines are impulse-reaction, tandem-compounded units operating on steam of 650 psi, 750 F. Each turbine is served by a 31,000 sq ft surface condenser.

Also located in the powerhouse are the two blast furnace blowers, each consisting of a single suction, four-stage, air-cooled blower driven by a 12-stage impulse type turbine. These units also operate on steam of 650 psi, 750 F, and are rated at 90,000 cfm, 30 psi. Condensers on these turbines contain 8300 sq ft of surface. Steam consumption of the turboblowers runs about 57,000 lb of steam per hr.

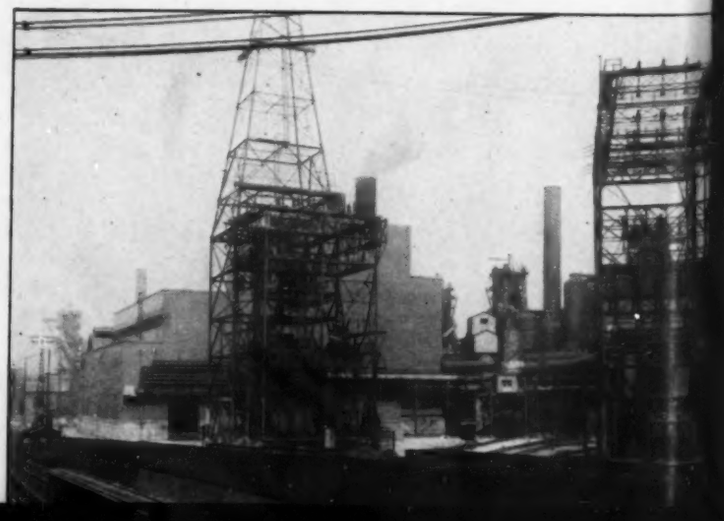
Water for the new facilities comes from the Monongahela River through an 8 ft concrete pipe to a screen house, where it passes through traveling screens and into an intake chamber. There are ten vertical pumps installed here, three of 22,500 gpm for turbogenerator condensers, three of 11,500 gpm for turboblower condensers, two of 2000 gpm for general service water, one of 8000 gpm for blast furnace cooling water, and one 1000 gpm fire pump. The last two units are turbine driven.

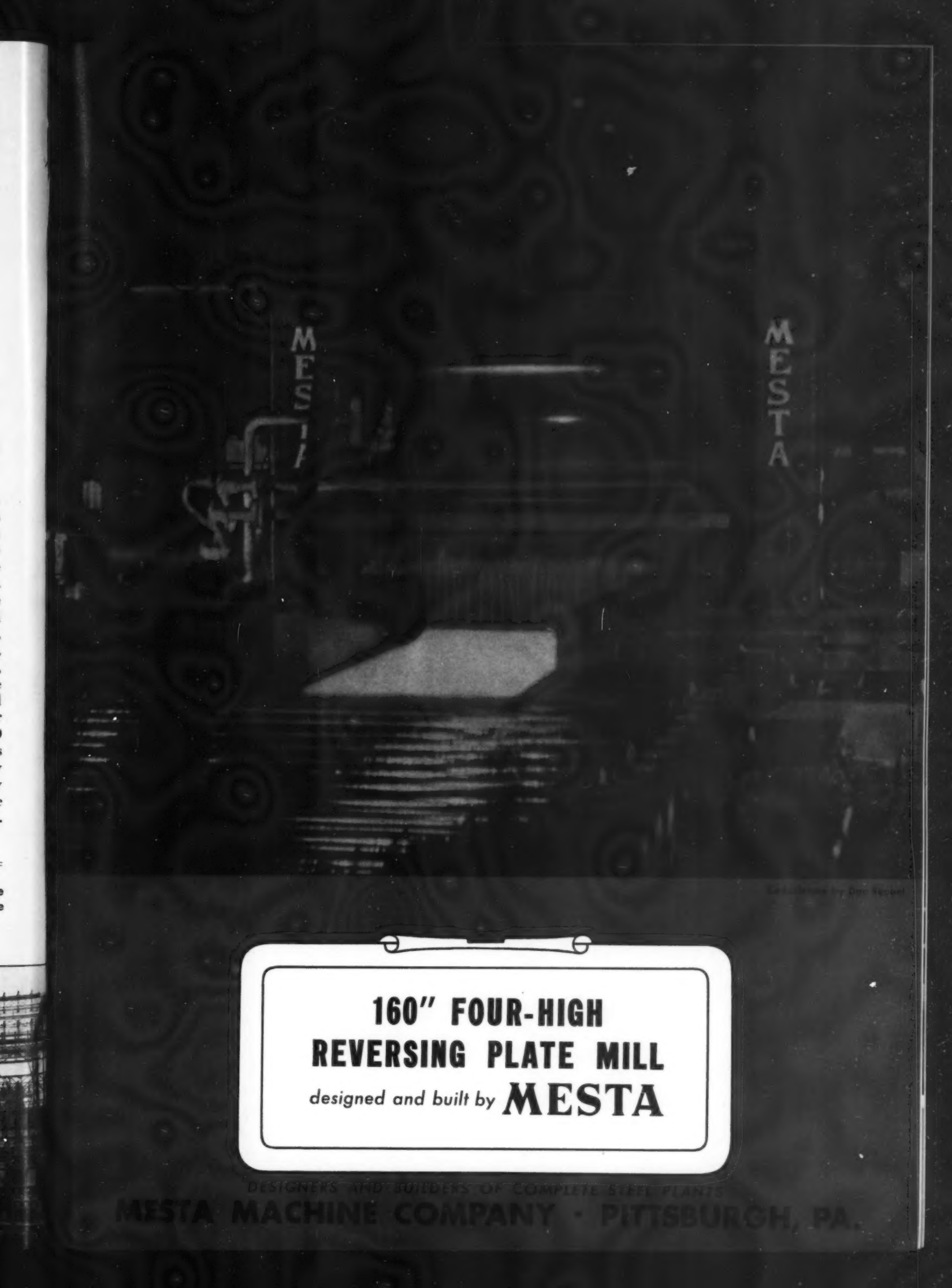
All water is treated with milk of lime to reduce acidity. The treatment is automatically controlled so as to maintain a pH value of 6.5.

Two more 8000 gpm vertical pumps draw waste water from the discharge from the powerhouse, reusing the water in gas washers and other blast furnace applications.

Power from this station goes into the company's inter-plant power systems, feeding through transformers into the 69,000 volt, 60 cycle system. This system is interconnected to the company's 44,000 volt, 25 cycle system through an electronic frequency changer. There are two duplicate frequency changers, each rated at 10,000 kw, connected between the 60 and the 25 cycle systems. The 60 cycle, 69,000 volt power is converted by large rectifier tubes into high voltage direct current, which is then fed to a second set of tubes where a second conversion changes the power to 25 cycle, 44,000 volts, which then flows through the 25 cycle system. Transformers rated at 13,120 kva are provided on each side of each frequency changer, with their connections arranged for 12 phase operation at 12,970 volts. Power can flow through the frequency changers in either direction, according to the needs and supply on either of the two power systems. The frequency changers can be operated singly or in parallel, and are capable of carrying 125 per cent load for two hours.

Exterior view of powerhouse, showing transmission line tower in foreground, and, to the right, bus structure and substation serving the frequency changers.



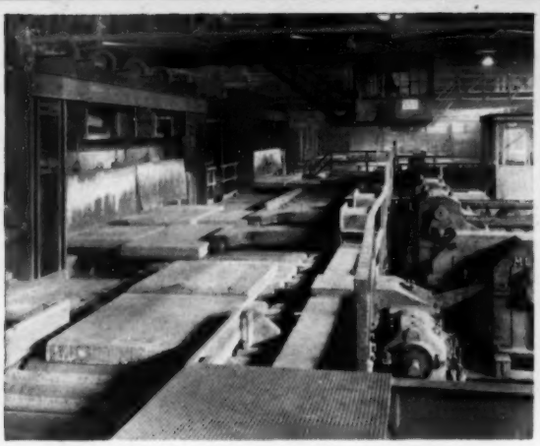


160" FOUR-HIGH REVERSING PLATE MILL

designed and built by **MESTA**

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY · PITTSBURGH, PA.

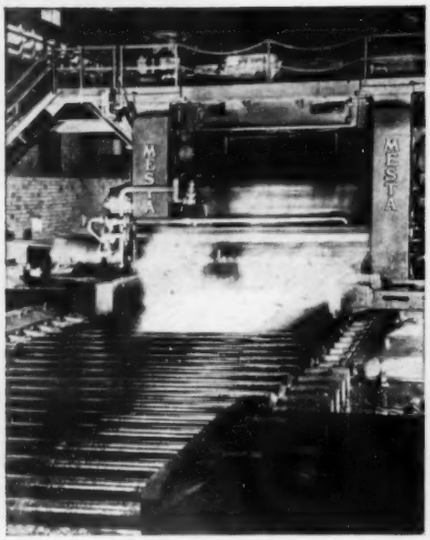


● Entry Side of Reheating Furnaces showing Mesta Slab Pusher

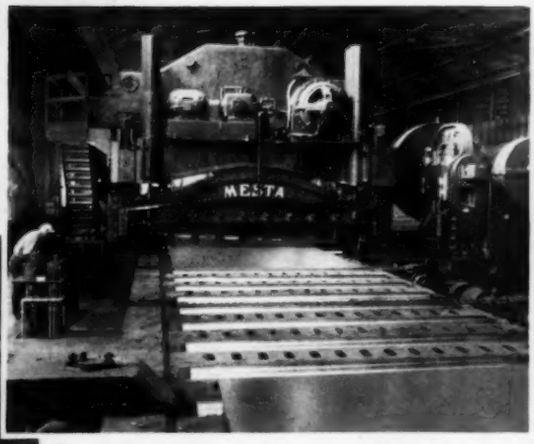
● 160" Plate Leveller installed in connection with Mesta 160" Plate Mill

MESTA

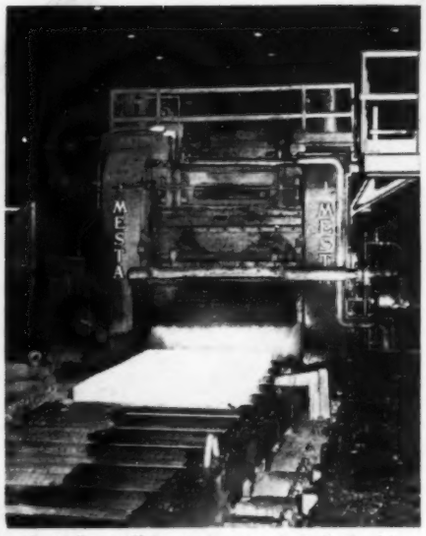
designed and built EQUIPMENT for the Carnegie-Illinois, Homestead Works



● Mesta 160" Four-High Reversing Plate Mill

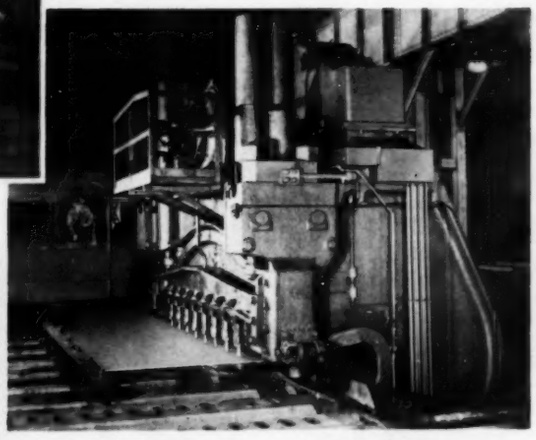


● End Plate Shear—Mesta 160" Plate Mill

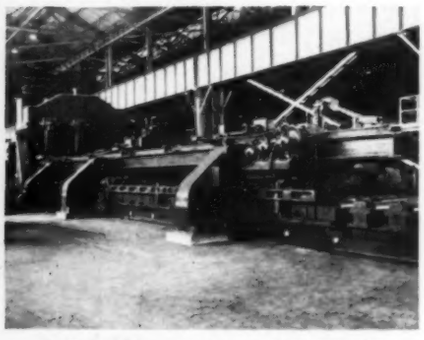


● 30" x 80" Scale Breaker installed with Mesta 160" Plate Mill

● Transfer and Plate Finishing Table —Mesta 160" Plate Mill



● 180" Side Plate Shear—Mesta 160" Plate Mill

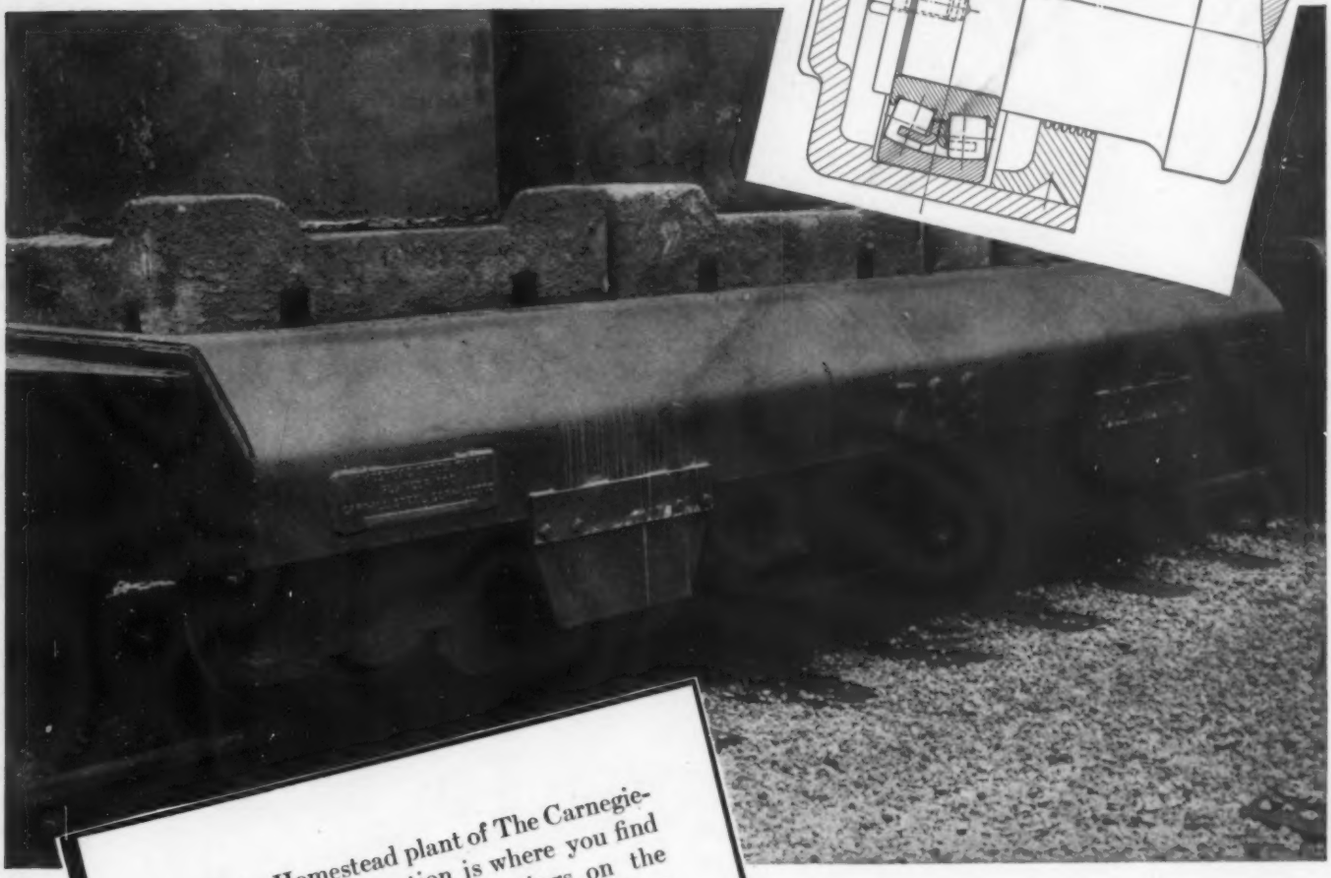


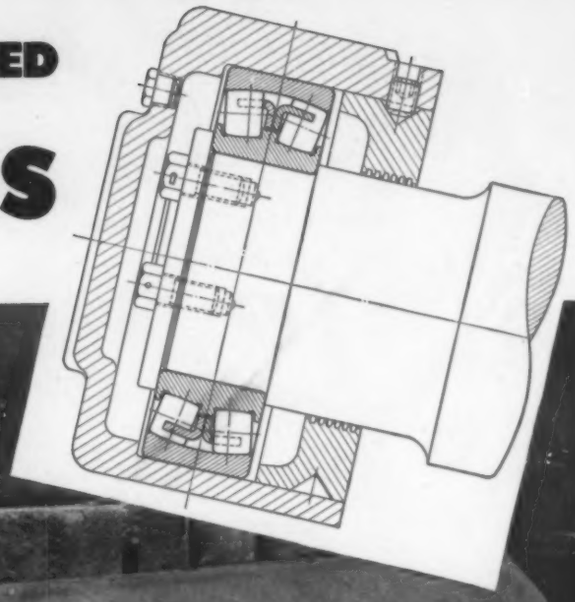
● Shear Gauge—Mesta 160" Plate Mill

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY, PITTSBURGH, PA.

WHY SKF's ARE USED ON INGOT CARS





Inside the Homestead plant of The Carnegie-Illinois Steel Corporation is where you find SKF Spherical Roller Bearings on the journals of these ingot cars. You find them there because SKF's have high radial and thrust capacity that overcomes warpage or deflections under heavy shock loads . . . because they have built-in alignment that eliminates binding . . . because they need no adjustments throughout a long life. Steel men with an eye on increased tonnage don't take chances on bearings. They use SKF's.

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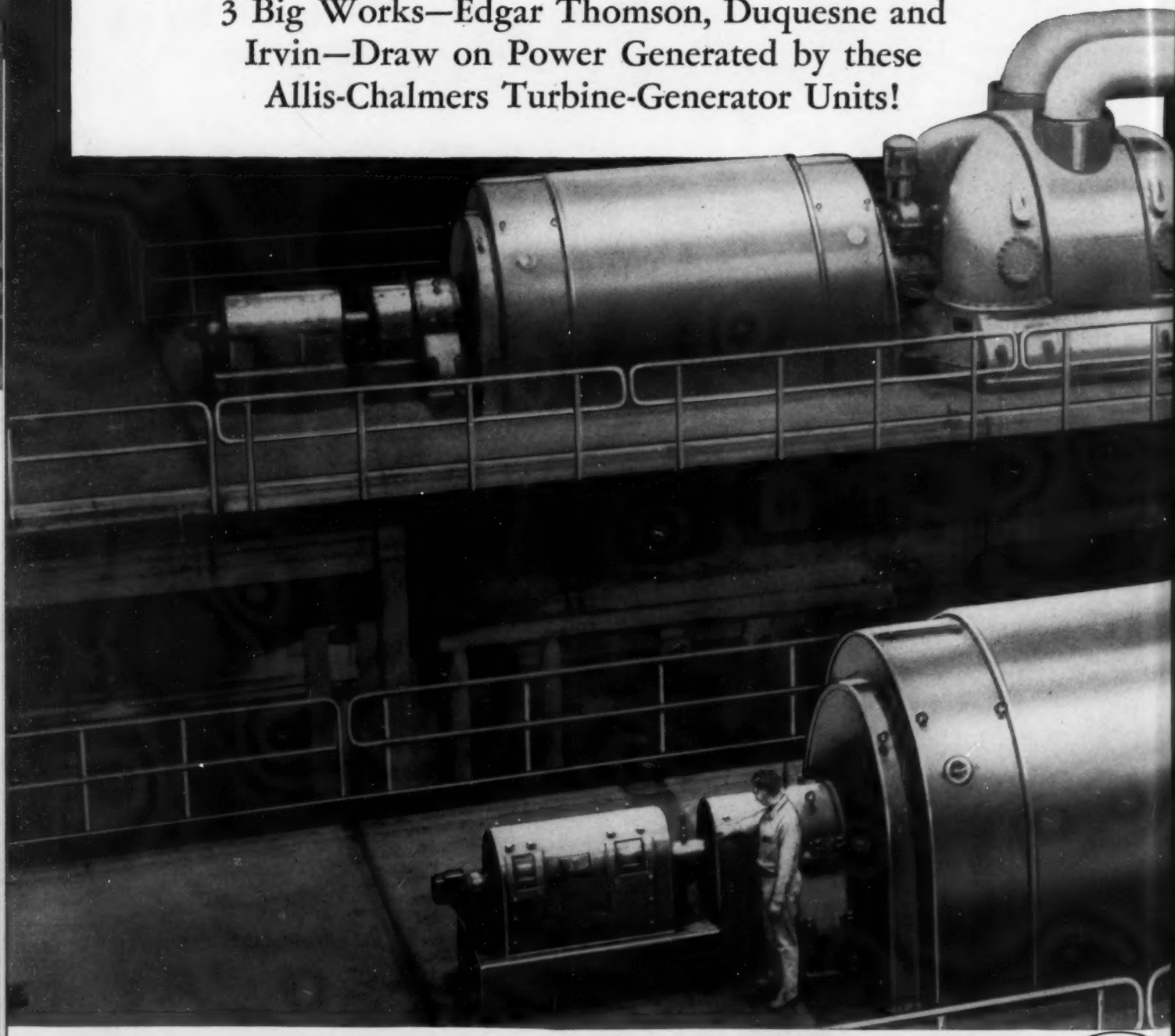
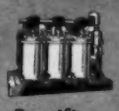
50,000 kw for Carnegie-Illinois!

3 Big Works—Edgar Thomson, Duquesne and Irvin—Draw on Power Generated by these Allis-Chalmers Turbine-Generator Units!



Transformers

Switchgear and Switchboards



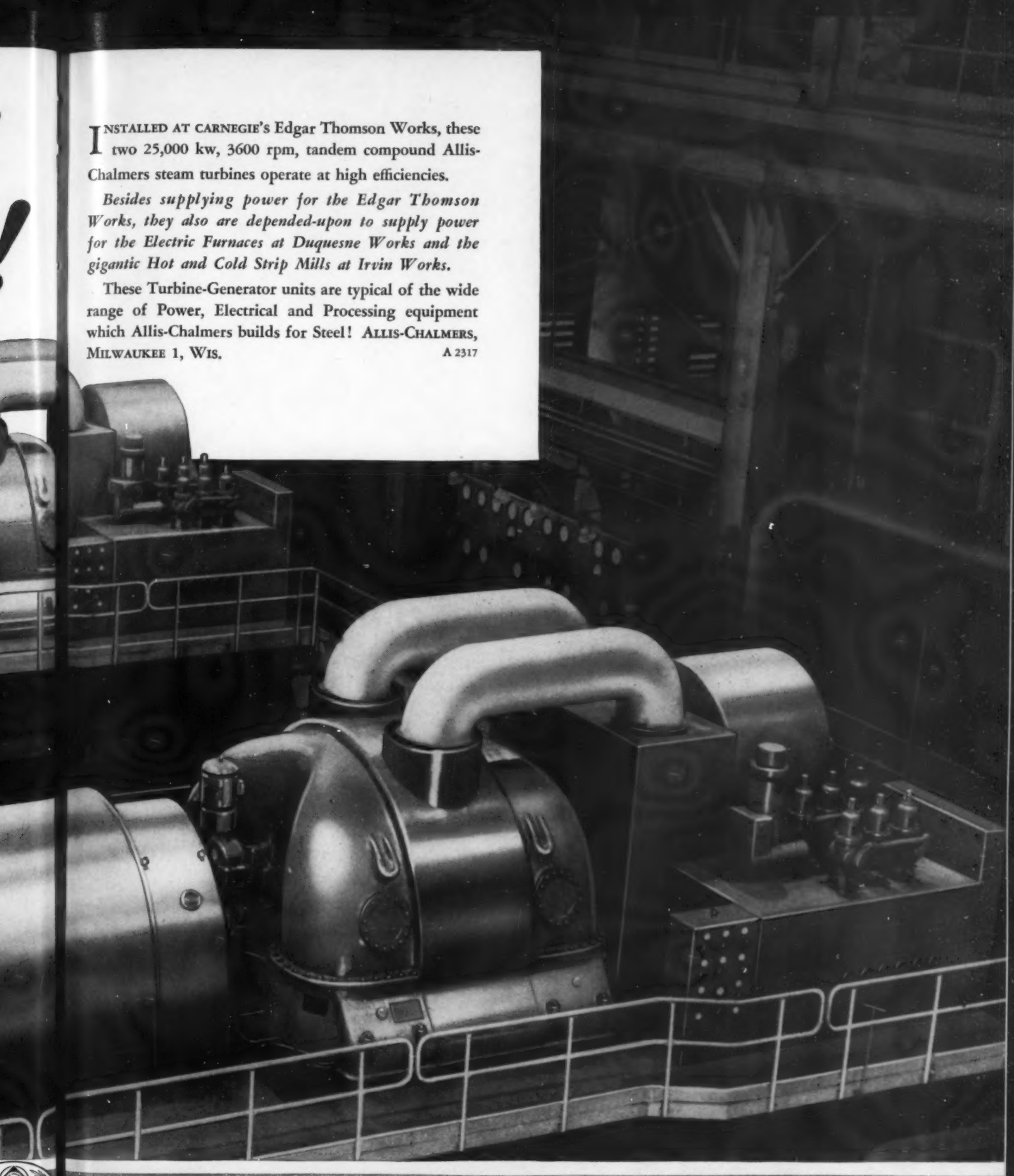
Rectifiers

Motors for Mill Drives

ALLIS

1847 1947 A CENTURY OF SERVICE to Industry THAT MADE America Great

One of the Big 3 in Electric Power Equipment—



INSTALLED AT CARNEGIE'S Edgar Thomson Works, these two 25,000 kw, 3600 rpm, tandem compound Allis-Chalmers steam turbines operate at high efficiencies.

Besides supplying power for the Edgar Thomson Works, they also are depended-upon to supply power for the Electric Furnaces at Duquesne Works and the gigantic Hot and Cold Strip Mills at Irvin Works.

These Turbine-Generator units are typical of the wide range of Power, Electrical and Processing equipment which Allis-Chalmers builds for Steel! ALLIS-CHALMERS, MILWAUKEE 1, WIS. A 2317

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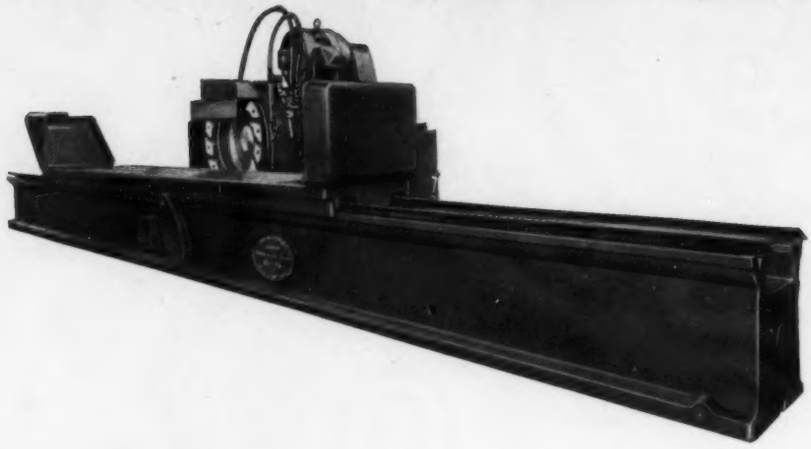

Look to
Bridgeport
FOR
SHEAR KNIFE GRINDERS

The Homestead Plant of Carnegie-Illinois Steel Corporation, like many other leading steel plants, uses a Bridgeport Hydraulic Shear Knife Grinder to keep shear knives in top condition. The No. 85 Bridgeport Grinder with magnetic chuck equipment does a fast, precision job on shear knives and is also available for many other types of grinding.

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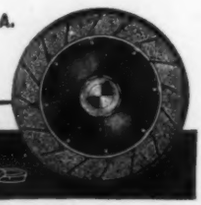
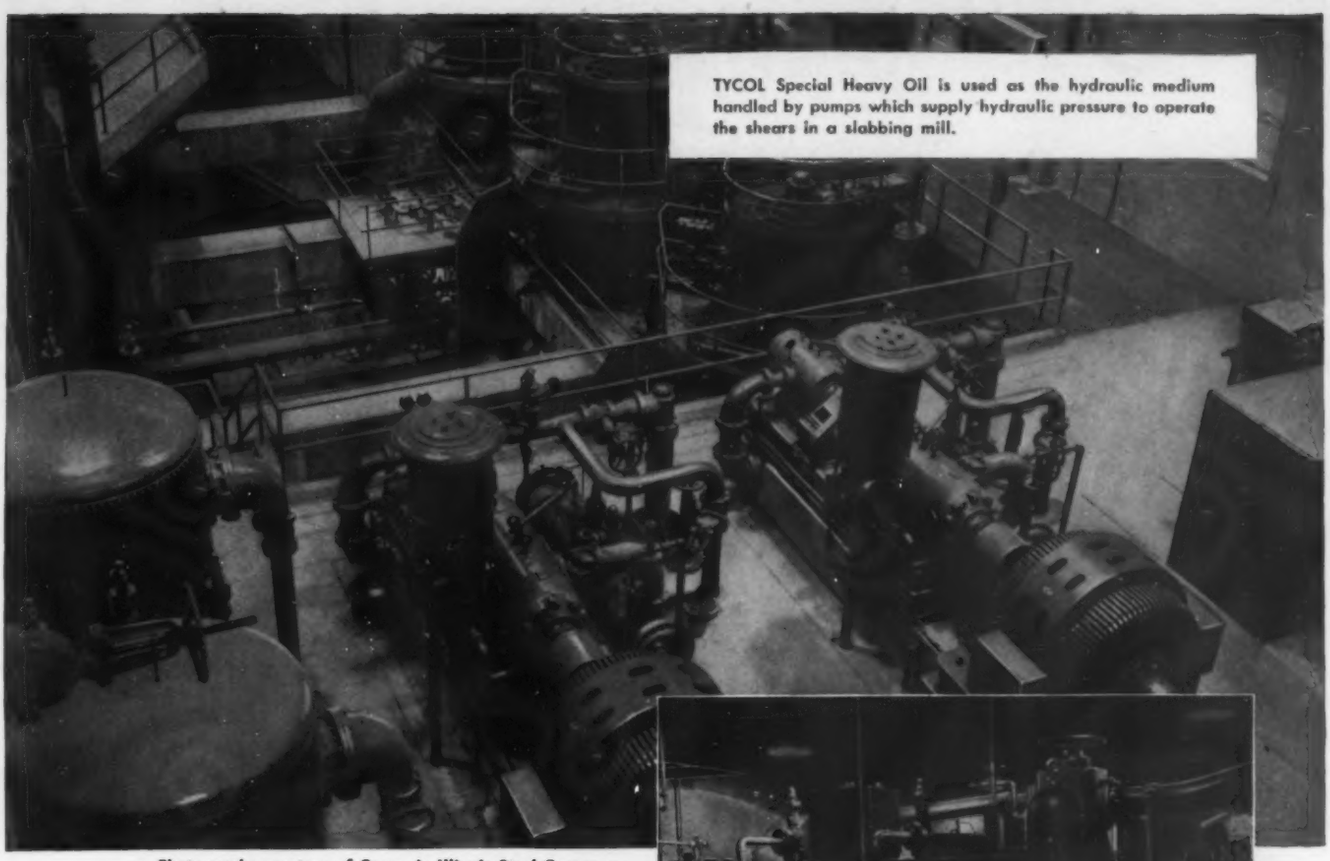
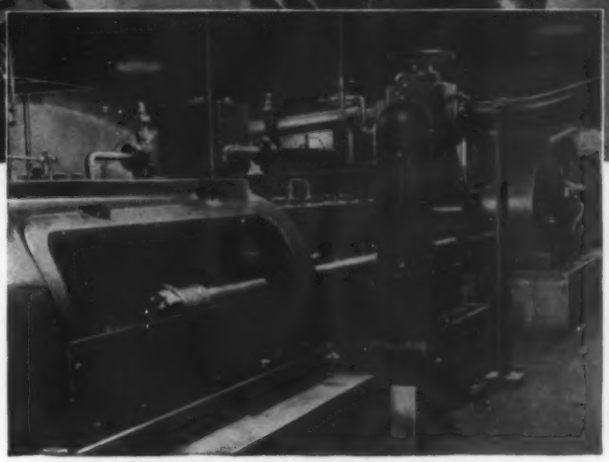




TYCOL Special Heavy Oil is used as the hydraulic medium handled by pumps which supply hydraulic pressure to operate the shears in a slabbing mill.

Photographs courtesy of Carnegie-Illinois Steel Company

Steel Company uses TYCOL Lubricants



TYCOL Heavy Oil lubricates air compressors.

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Tide Water Associated is thoroughly experienced in all phases of industrial lubrication. They will be glad to help you select the Tycol oil or grease best suited to your specific need. Call, write or wire your nearest Tide Water Associated office for full details – now.

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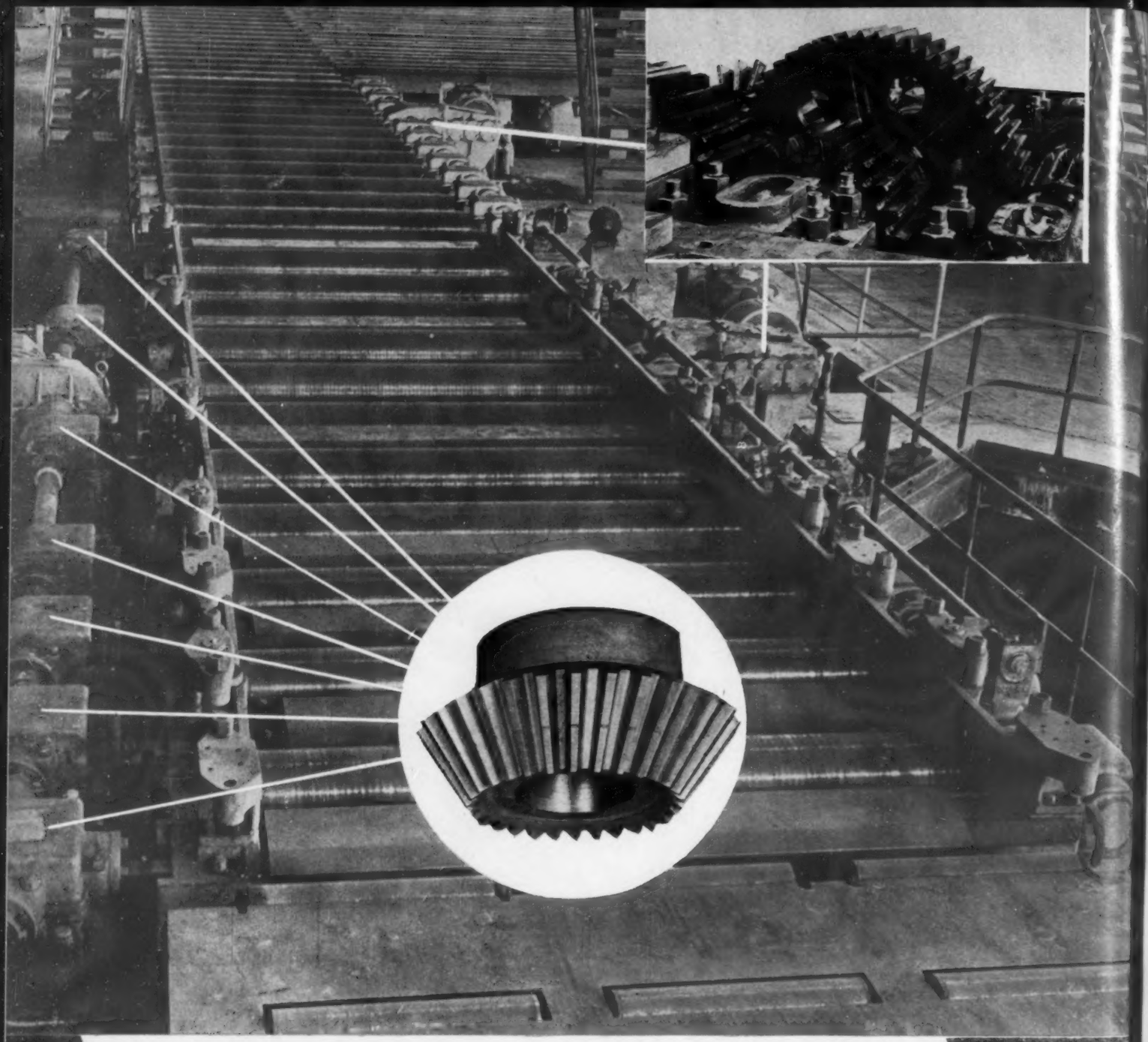
LUBRICATION—"ENGINEERED TO FIT THE JOB"



GEAR LIFE *measured in years . . .*

"Tool Steel" table gearing is providing 8 to 10 times the life of untreated steel, 3 to 4 times that of oil hardened steel, and 2 to 3 times the life of special quenched or case hardened steel.

Here's Why!

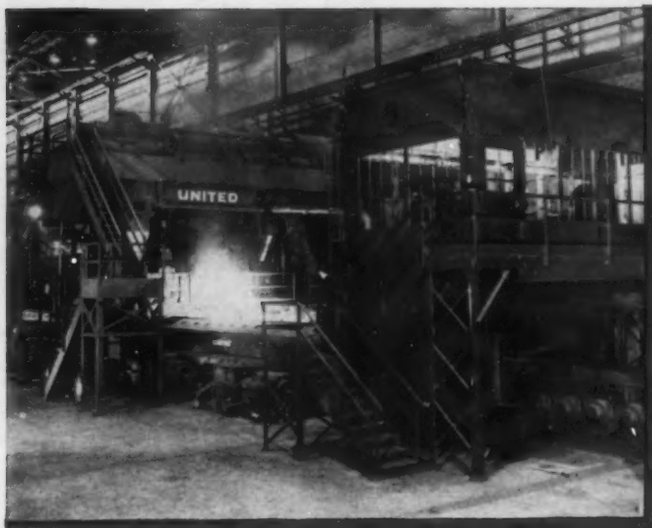
Wearing surfaces (670-740 Brinell) are unfileable, and cores (200-500 Brinell) are fully refined for toughness and ductility. And remember, each "Tool Steel" gear carries a written guarantee. So investigate these facts today.

"TOOL STEEL" PROCESS

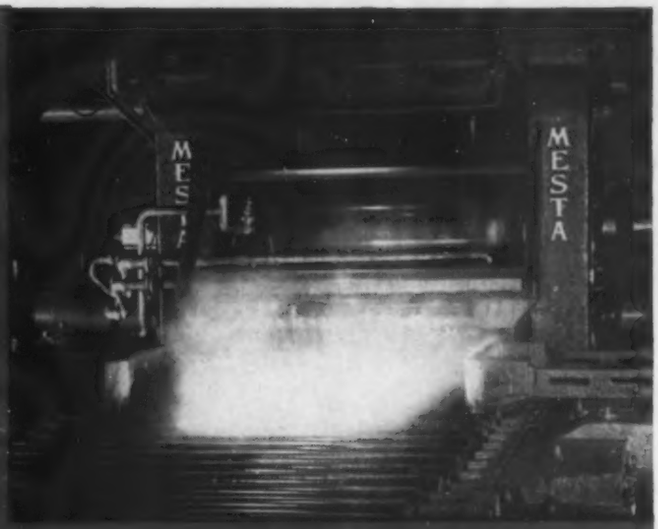
The Standard of Quality for GEARS· PINIONS· ROLLS· SPROCKETS· WHEELS *and other* HARDENED PRODUCTS

THE TOOL STEEL GEAR & PINION CO.

CINCINNATI 16, OHIO

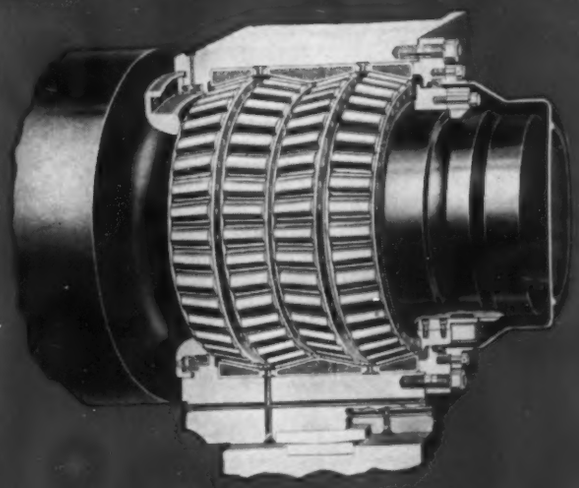


Two High 80" Slabbing Mill built by United Engineering and Foundry Company.



Four High 160" Plate Mill built by Mesta Machine Company.

TIMKEN BEARINGS Keep Things Rolling at Homestead Works



TIMKEN

TRADE NAME REG. U. S. PAT. OFF.

ROLL NECK BEARINGS

Following is a list of rolling equipment at Homestead Works of Carnegie-Illinois Steel Corporation using Timken Bearings on roll necks and at other positions.

Four High United Finishing Hot Plate Mill, 27" and 54" x 100", (4 stands) installed 1936. Timken Bearings on all back-up and work roll necks and mill drives.

Four High United Reversing Hot Mill, 36" and 54" x 120", (one stand) installed 1937. Timken Bearings on all back-up and work roll necks and mill drive.

Universal Beam Mill, 52", installed 1927. Timken Bearings on vertical rolls.

Two High United Slabbing Mill, 45" x 80", installed 1942. Timken Bearings on all roll necks, screwdowns, edger drives, tables, table drives, ingot transfer car and shear.

Four High Mesta Plate Mill, 38" x 58" x 160", installed 1942. Timken Bearings on all work rolls and tables.

Timken Bearings have a splendid record of accomplishment in all of this equipment. The slabbing mill for example consistently has out-produced any other slabbing mill ever built, while in the 160" plate mill which it feeds, no Timken Bearing ever has had to be repaired or replaced. The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION ✳

PENNSYLVANIA ENGINEERING CORP.

NEW CASTLE, PENNA.

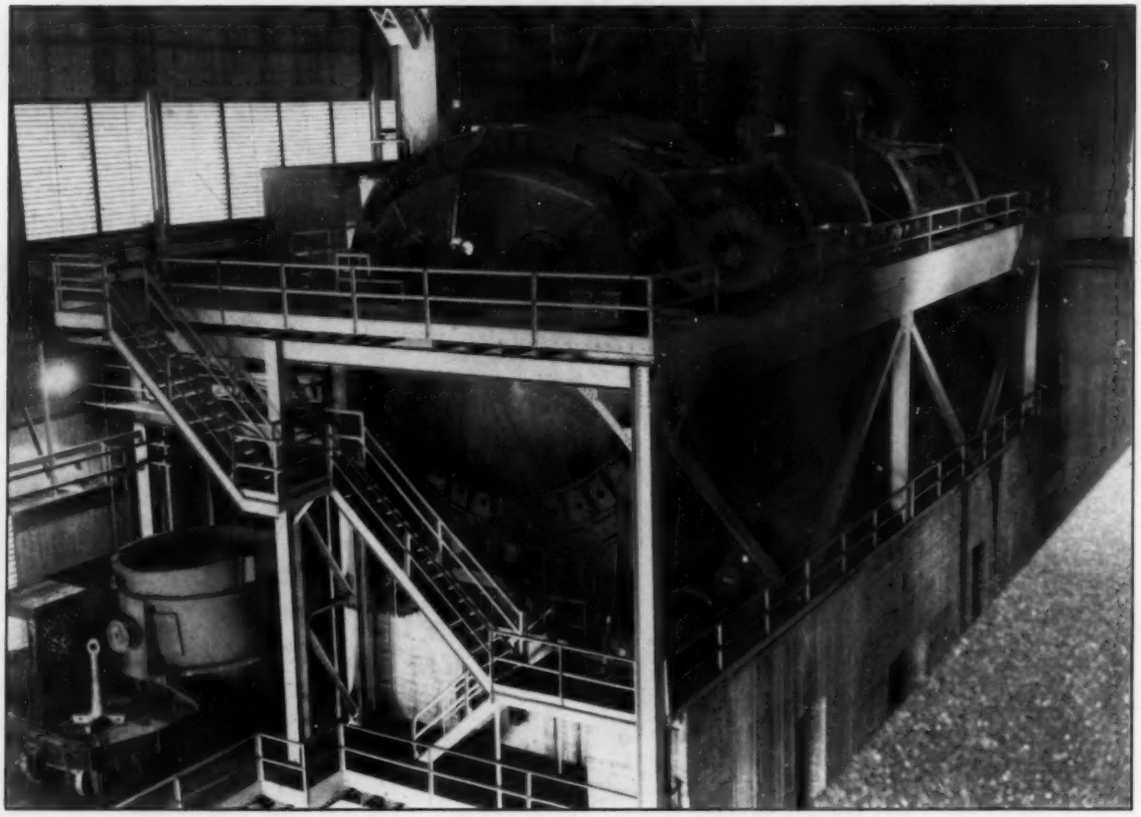
Designers, Fabricators and Erectors of

HOT METAL MIXERS

FOR

BESSEMER AND OPEN HEARTH PLANTS

25 — 2000 TON CAPACITY



2 — 800 TON MIXER INSTALLED AT CARNEGIE-ILLINOIS' HOMESTEAD NEW OPEN HEARTH PLANT

Installation of Mixers

in the following steel plants

Wheeling Steel Corporation
Carnegie-Illinois Steel Corporation
National Tube Company
Tata Iron and Steel Company, India
Jones and Laughlin Steel Corporation
Amtorg Trading Corporation, Russia
Weirton Steel Company
Tennessee Coal, Iron & Railroad Company
Bethlehem Steel Company
Algoma Steel Company, Canada
Youngstown Sheet and Tube Company
Republic Steel Corporation
Siderurgica del Mediterraneo, Spain
Inland Steel Company
Monterrey Steel Company, Mexico
Cia Acos Especiais Itabira, Brazil
Great Lakes Steel Corporation
National Steel, Brazil

25-TON BESSEMER CONVERTER

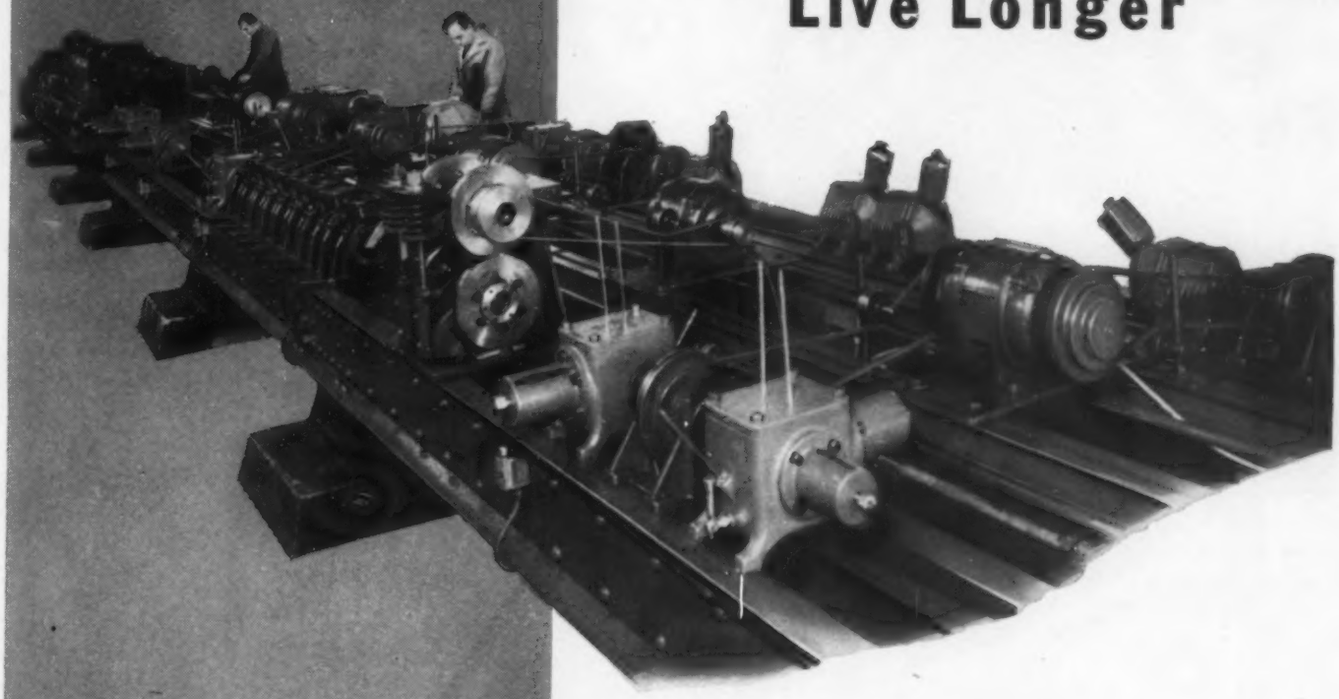
Auxiliary Equipment

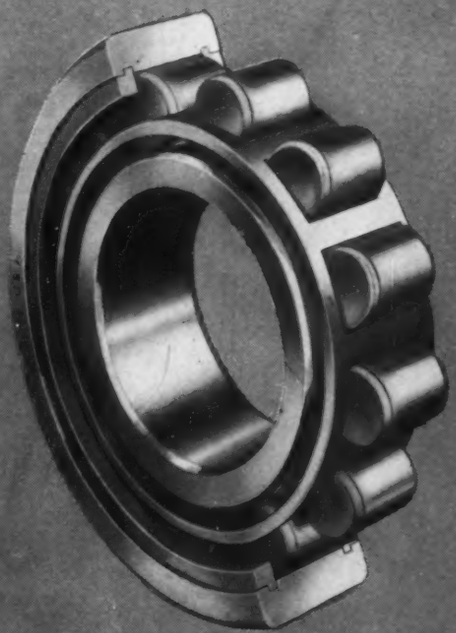
for Open Hearth and Bessemer plants

Converters
Tilting Open Hearth Furnaces
Ladles
Ladle Stands
Ladle Transfer Cars
Cupolas
Slag Cars
Dragouts
Slag Pots
Jib Cranes
Jack Cars
Bottom Oven Cars
Bottom Ovens
Post Ladle Cranes
Ingot Cars
Scrap Buckets
Charging Box Cars
Blast Furnaces

A DESTRUCTION LINE

...That Helps Bearings Live Longer





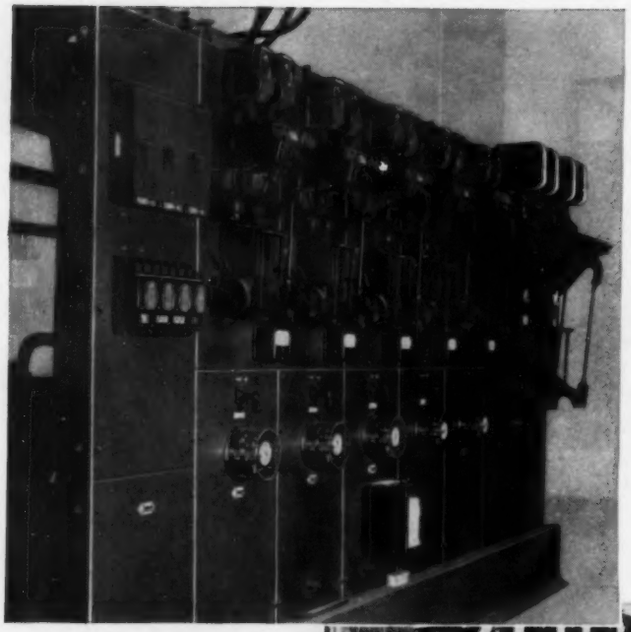
Supplementing the many eagle-eyed process inspections that each Hyatt Roller Bearing receives—beginning with raw material and following through every manufacturing operation—is our Destruction Line, pictured above.

Here bearings picked at random from the production line are placed in testing rigs which scientifically emulate the actual operating conditions of the bearings. They are kept running to the point of destruction.

Thus we can see ahead through the years what is expected of the bearings for the job they are designed to do. This pre-determined quality—plus such Hyatt features as inter-changeability of parts, to facilitate assembly; and maximum capacity for a given space permitting more efficient product design—combine to make Hyatt *first choice* of experienced designers. Years of care-free application have proved the wisdom of their choice. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

AT CARNEGIE-ILLINOIS, TOO,



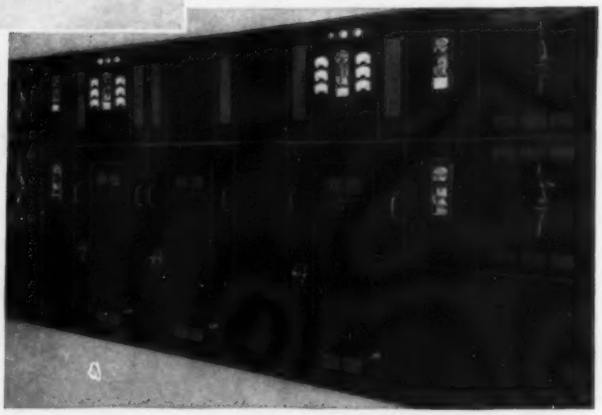
In the Carnegie-Illinois Steel Corporation's giant Homestead plant—one of the largest steel expansion projects of World War II—I-T-E equipment provided the electrical protection.

The Duquesne Works' giant electric furnaces; the Armor and Forging department at Homestead; and the great blast furnaces and No. 2 power house of the Edgar Thomson Works, all rely on I-T-E Switchgear for protec-

◀ 250 V. D-C Distribution switchboard of the Duquesne Works' Electric Furnace Department. 5 I-T-E Type LX breakers, and 2 I-T-E Type KC breakers provide the electrical protection for this vital plant. (Switchboard by Allis-Chalmers.)

◀ The electrical center in the Armor and Forging department of the Homestead Works is this 250 V. D-C Power Distribution switchboard. 5 I-T-E Type LG two-pole breakers; 2 I-T-E Type LG three-pole breakers; and 2 I-T-E Type KB breakers are mounted on the board (built by Penn Electrical Co.).

I-T-E *Multumite*, 480 V. A-C ▶ Power Distribution switchboard in the Blast Furnace Substation of the Edgar Thomson Works. *Multumite* assembly is 8 frame, 3 phase, 60 cycle, indoor drawout type, housing 3 Type LG truck-mounted breakers, and 5 Type LX pantograph-mounted breakers. *Multumite* switchboards are an exclusive product of I-T-E.



I-T-E MILL TYPE SWITCHGEAR

THE I-T-E CIRCUIT BREAKER CO., 19TH & HAMILTON STREETS

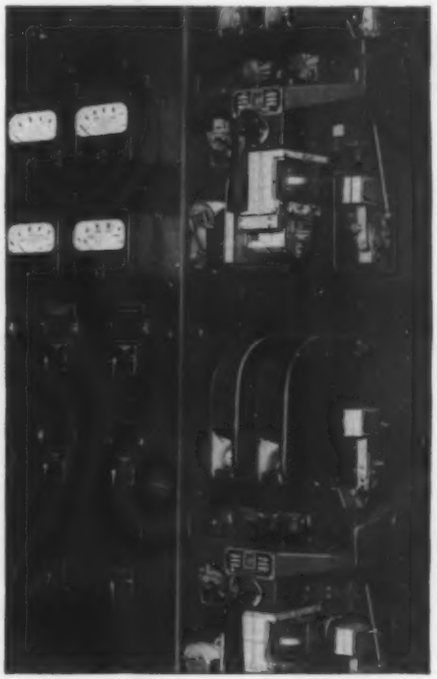
SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • AUTOMATIC RECLOSING

ELECTRICAL PROTECTION IS I-T-E

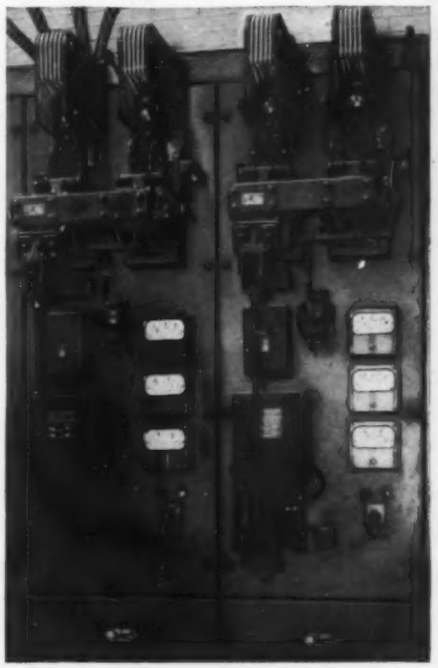
tion of this electrical distribution system.

The better designed, better built I - T - E circuit breakers served the Homestead plant with complete dependability through the strenuous war-production years, and they are still serving—still demonstrating their superior operating characteristics under the heavy operational demands of post-war production.

• The I-T-E representative in your locality will be glad to assist you in applying I-T-E Mill Type Switchgear to your electrical distribution system. Use his services without obligation.



I-T-E TYPE KB CIRCUIT BREAKERS
(Available for both A-C and D-C applications) Open or dead front type; 25,000 rms. Amp. interrupting rating; 2, 3, or 4 pole; 250 Volts D-C; 600 Volts A-C; 50 to 600 Amp. Available for both manual and electrical operation. Electrically operated breakers utilize solenoid mechanism, closing relay, and shunt-trip coil for remote tripping.



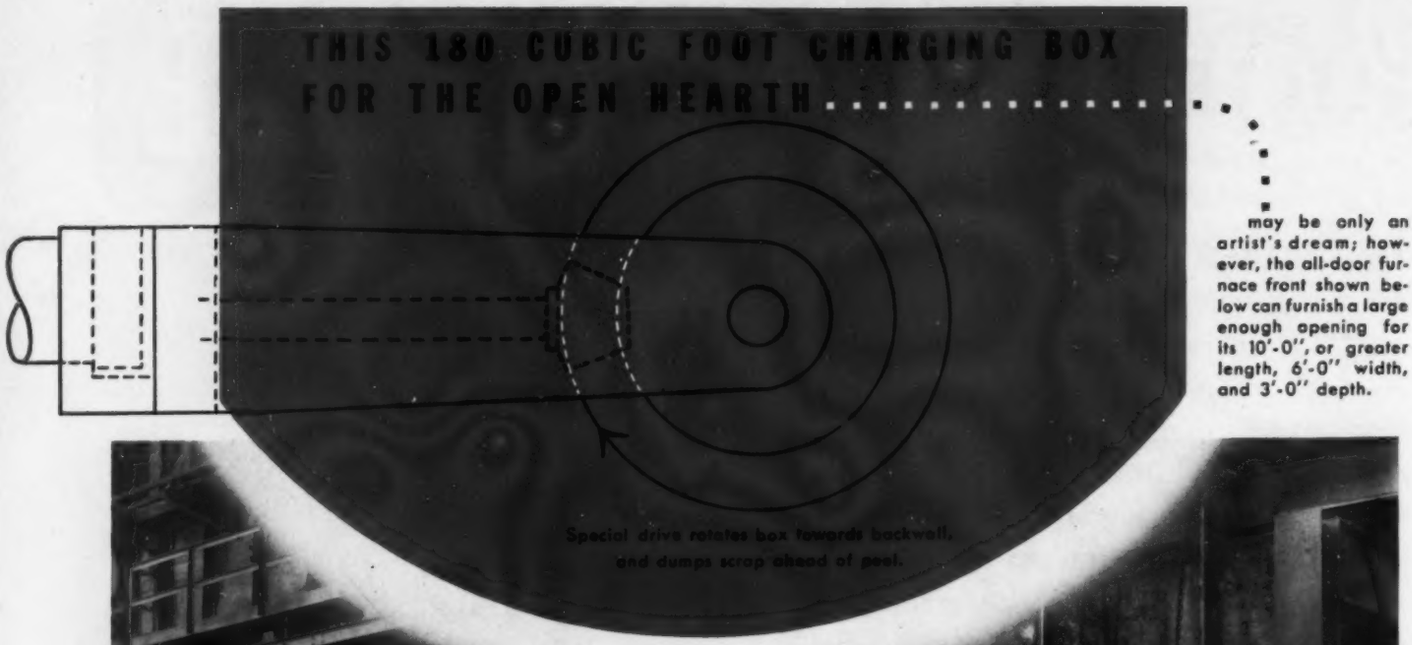
I-T-E TYPE LG CIRCUIT BREAKERS
(Available for both A-C and D-C applications) *A-C breakers* are open or dead front type; electrically operated; 2, 3, or 4 pole; 600 Volts and under. Interrupting rating is 75,000 rms. Amp. in capacities 2000 to 3000 Amp.; and 100,000 rms Amp. in capacities 4000 to 6000 Amp. Calibrated range of dual overcurrent trip, with time delay, is 100% to 200% of continuous rating, while the instantaneous trip is set at 1200%.

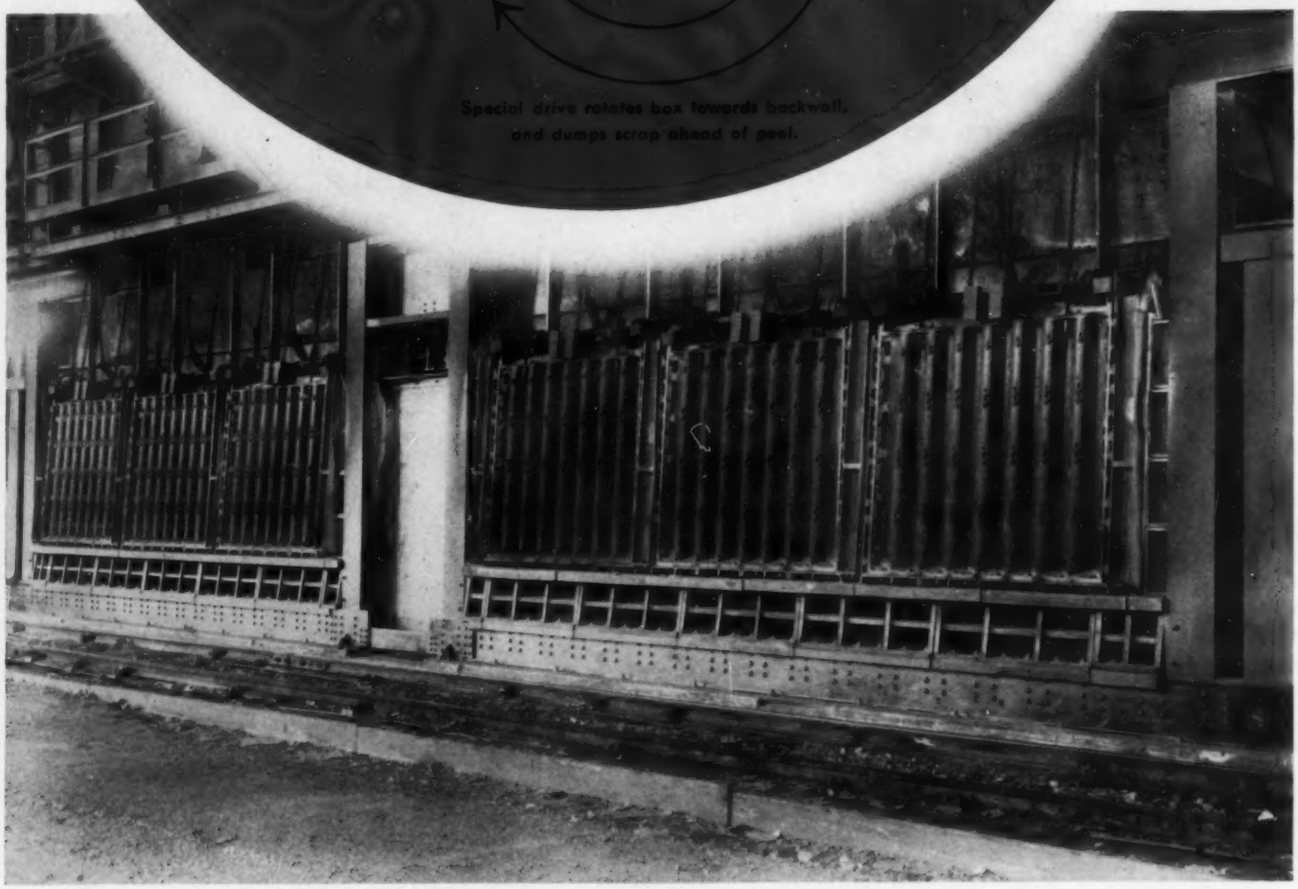
D-C breakers are open or dead front type; electrically operated; 2 or 3 pole; 750 Volts and under. Interrupting rating is 75,000 rms Amp. in capacities 2000 to 3000 Amp.; 100,000 rms Amp. in capacities 4000 to 10,000 Amp. Calibrated range of the dual overcurrent trip adjustment, with time delay, is 100% to 200% of continuous rating, while the instantaneous trip is set at 800%. Both A-C and D-C breakers are equipped with magnetic arc chutes; closing solenoid; solenoid air-check to control closing impact; non-repeat trip-free relay; shunt trip for remote opening; a solenoid operated "bb" switch to operate the non-repeat relay; and a six contact auxiliary switch.

The Leader In Technical Excellence

PHILADELPHIA 30, PA. • 31 OFFICES IN THE UNITED STATES AND CANADA

CIRCUIT BREAKERS • HIGH SPEED CIRCUIT BREAKERS • RESISTORS • SPECIAL PRODUCTS


THIS 180 CUBIC FOOT CHARGING BOX
FOR THE OPEN HEARTH
may be only an artist's dream; however, the all-door furnace front shown below can furnish a large enough opening for its 10'-0", or greater length, 6'-0" width, and 3'-0" depth.
Special drive rotates box towards backwall, and dumps scrap ahead of peel.



Above photo shows the front of a two-chamber, "In-and-Out" type, slab reheating furnace — each chamber is equipped with three consecutive doors which enclose a 21′ 0″ unobstructed charging opening — there are no buckstays, no door jambs, and no door frame legs between doors.

The Carnegie-Illinois Steel Corporation has five of these "all-door" front furnaces serving heated slabs to the 160″ plate mill at their Gary Works, and two at their Homestead Works on the 160″ plate mill. All seven furnaces have a total of forty-two doors, which, to date, have been in service ranging from 3½ to 5½ years.

This "all-door" design requires no door frames, since each door is rolled up and down free of any sliding friction, by means of an overhead truck attached to the door and a pair of vertically extending rails mounted on the furnace. The suspended roof is arranged to serve as the door lintel which eliminates the door arches or water cooled archless door element. The cast steel, dry doors, as shown have proven highly satisfactory against heating furnace temperatures. The same door can be furnished in a water cooled design for use on the open hearth furnace.

FRAZIER-SIMPLEX INC. 436 EAST BEAU ST., WASHINGTON, PA., U.S.A.

As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

13 *SPEEDAIRES* in auto forge shop save money, weight and space

THIRTEEN Speedaires are at work in this auto forge shop. Three drive cold scrap trim conveyors, two operate scrap rattlers, and eight drive cold billet conveyors. For each application, Speedaire offered three big advantages—a saving in cost, a saving in weight, and a saving in space occupied. The unit shown here, driving a scrap conveyor, weighed 25% less, took 40% less space than a conventional worm-gear unit required to do the work, and saved $84.50.

Speedaire is Cleveland's new fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work—will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantages of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands.

For full description, send for Catalog 300. The Cleveland Worm & Gear Co., 3278 E. 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

Blooming mill power cost cut 3¢ per ton

BY reducing friction at the roll necks through positive lubrication, a Farval centralized lubricating system can save thousands of dollars a year in power costs.

On one 40" blooming mill, for example, the records show that power cost per ton of steel rolled was lowered 3.1¢ by installing Farval. On the basis of tonnage rolled, it took less than 3½ months for the Farval system to pay for itself.

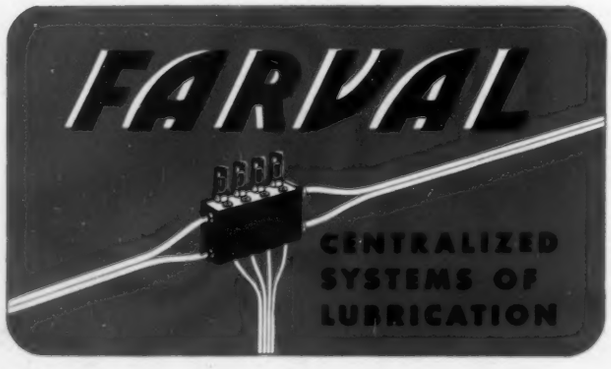
Farval was installed to automatically lubricate the bearings on both the blooming mill and the tables, all motor driven. Power is supplied by the company's own plant, at ½¢ per kw-hr. Here are the vital "before and after" figures:

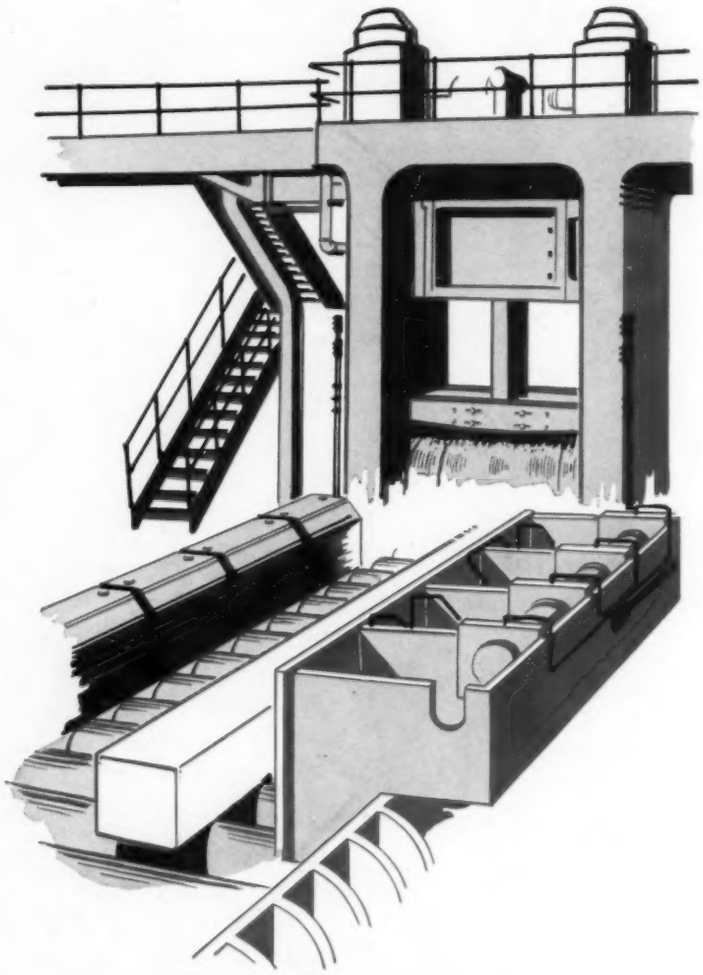
Method of lubrication employed	Cost of power for one year	Tons of steel rolled in year	Power cost per ton of steel
Roll necks hand packed .	$42,300	470,000	$.090
Centralized lubrication . .	$37,170	630,000	$.059
Saved in power cost per ton with Farval .			$.031
Total power saving on 630,000 tons rolled			$19,530
Total cost of Farval installation			$ 5,500

To measure the full value of Farval, to the savings on power should be added the savings in labor of oiling, the savings in lubricant, the increased life of bearings and the increased tonnage produced through the elimination of mill delays and shutdowns for bearing replacement.

Farval delivers oil or grease under pressure to a group of bearings from one central station, in exact quantities, at regular intervals. Farval is the Dualine System with the Positive Piston Displacement Valve. This valve has but two moving parts and is fully adjustable, with a Tell-tale indicator at each bearing to show the job is done. For a full description of Farval, write for Bulletin 25. The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers, Limited.





FARVAL—*Studies in Centralized Lubrication* No. 91

MAINTENANCE IN THE BOILERHOUSE

. . . . describing some maintenance practices in a steel mill power house . . . .

By L. D. HOADLEY
Engineering Department
Great Lakes Steel Corporation
Ecorse, Michigan

▲ MECHANICAL maintenance in a plant the size of the Blast Furnace division of Great Lakes Steel Corporation is so broad and of such varied character that a thorough treatment at this time is far beyond the scope of this paper. Therefore, in order to bring out a few points, this paper will be limited to a discussion of mechanical maintenance as it applies to the boiler house. In general, this paper will only discuss conditions as they are found on Zug Island, and these may be characteristic only of this plant, but will serve to illustrate the manner in which the problems are handled.

The normal 425 psi steam load for the entire division varies seasonally from 5,500,000 to some 7,000,000 lb per day. This figure fluctuates rapidly with blast furnace operations from day to day, in fact, from hour to hour. To produce this steam, there are five boilers available. It has been the practice for several years to keep four units in service while the fifth is being repaired. In order to meet peak demands, previous to this year, it was essential that all five boilers be on the line during the months of July and August. This practice necessitated that all boiler repairs be made during the other ten months. Dependent on the amount and kind of maintenance necessary on each unit out of service was the time required for making these repairs.

This boiler maintenance program is divided into two main classes, that dealing with the internal cleaning of the drums, tubes, headers, as well as the combustion chambers, and that dealing with service and repairs to all boiler auxiliaries, including piping, valves, and controls. It has been found inadvisable to plan to make repairs of any nature during a "run" which will normally extend from six to eight months. Of course, emergency temporary repairs are sometimes resorted to in order to keep the affected unit working until such time as a permanent job can be done when the boiler is out of service.

When it becomes necessary to take a boiler off the line for repairs, a work list is made up showing all items which require attention during the shutdown period. From this list, it is possible to schedule the repair work in such a manner that interference between various workmen will be held to a minimum. Major repairs or construction changes are scheduled for this period and, when necessary, additional help is brought in to augment the normal force engaged in repair work.

All drums and tubes are washed out and the tubes are turbined. Care is exercised to be sure that all tubes are open to allow free circulation of water. Before manheads and hand-hole covers are replaced, the seats are carefully inspected, and any cuts which may later cause leaks are ground out and new gaskets used when the covers are replaced. After this internal cleaning, the boiler is given a hydrostatic test in excess of normal working pressure. Any leaks are checked and measures are taken to eliminate them before the boiler goes into service again. This may necessitate tube rolling or even tube replacement.

While the boiler is being cleaned internally, the combustion chamber is inspected for necessary repairs to soot blowers and brickwork. In general, this detail is most necessary on the two boilers on which coke breeze is used. Here cracks in the brickwork, especially in the front arch, are inspected and pointed up. It has been noted that particles of coke become lodged in these cracks and later ignite and burn back around the hangers and the supporting steelwork. This may cause overheating and serious damage at this point.

The condition of all gas burners is noted, and such repairs as can be made at this time are completed, while more extensive replacements are planned for future shutdowns, if necessary.

As far as possible, all gas and air valves and controls are cleaned and checked to see that they will function correctly and with the least possible amount of trouble during the normal operation cycle.

Whereas the cleaning maintenance usually involves routine work, that dealing with the boiler auxiliaries very often involves considerable repairs. This is especially true when the steam turbines on the induced and forced draft fans are taken down for internal repairs. The units are single stage Terry wheel type machines

Presented before AISE Detroit District Section Meeting, November 12, 1946

and normally give very little trouble. Therefore, they are not taken down unless it is felt that steam nozzles, bearings, or shaft seal rings are in need of attention. When this work is necessary, it means that the turbine wheel and shaft will receive a complete overhaul job, including new shaft, if the latter is badly scored by the seal rings. When this work is necessary, it involves a major repair job and it has been found almost impossible to estimate the time required. Experience has proved that considerable time may be expended in getting the top half of the turbine off. This is especially true if the unit has never been apart before.

When inspected, the forced draft fans very seldom require much work, except possibly bearings or coupling repairs. However, the induced draft fans on the two breeze-fired units require considerable attention.

A fan wheel will last about two runs, or about twelve to eighteen months. They are subjected to considerable abrasion and the blading, although hard surfaced, erodes away. The badly worn wheels are shipped back to the factory and rebladed for reuse at a later date. At the time the wheel is changed, the housing or case is repaired. In place of fitting a bent wear plate in the curved section of the housing, it has been found to be easier and much quicker to weld a series of flat bars across the housing parallel with the shaft. This presents a practically smooth curved surface which has proved very effective and wear resistant in operation.

Before leaving the induced draft fan, the repair crew will service the speed reducer on the fan drive. This will include draining and replacing the oil in the system. The oil cooler will be cleaned and checked for leaks. This oil cooler has proved to be a vital piece of equipment in this setup. Failure because of tube leakage has seriously affected the operations and, in several instances, necessitated emergency shutdowns of the affected fan in order to plug the leaking tube in the oil cooler. It has been found impossible to operate these speed reducers without adequate oil supply at the proper quality and temperature. This means emergency operation measures must be taken to maintain steam supply during this emergency repair. Consequently, every effort is expended to be reasonably sure of the condition of these oil coolers during a regular shutdown inspection and necessary repairs are made at that time.

Because of the chain grate stoker with its more elaborate wind boxes below, there is usually more mechanical work to be done on those units equipped to burn coke breeze as a fuel than on the gas-fired units. However, by proper planning of future repairs, it is possible to schedule this work in such a way that a portion can be done at each shutdown period. The normal repair work on these units usually consists of inspection of the stoker drive. This includes a variable speed reducer, as well as a worm and worm gear reducer. The condition of all of the wearing points is noted, and future repairs are planned from results of these inspections if the job is too large for the present shutdown.

Although the foregoing discussion indicated considerable work necessary when a boiler comes off the line for repairs, there still remains a wide variety of maintenance on other equipment from time to time in the boiler house. This may involve cleaning of a filter, which is part of the lime soda process of water conditioning in use in this plant. At one time, this problem was very serious because of the excessive amount of cleaning time and "down" time necessary for each filter. A close study of this condition led the operating department to try several methods of operating procedure, some of which gave encouraging results. It has been possible to extend the time between filter cleanings from two months to well beyond eighteen months. This is an important item because of the labor involved in cleaning a filter. All of the filter media, which is a type of coal, must be removed from the filter tank. It is then water washed to remove as much as possible of the lime-like material adhering to the particles of coal. After washing, the coal is graded for size. The cleaned and sized coal is now ready to be placed in the tank in layers of the proper size and depth. However, before replacing the coal in the tank, all piping and spray heads in the distribution system located in the bottom of the filter tank must be removed and cleaned. This was one point where excessive maintenance was greatly reduced by the operational changes mentioned above.

Occasionally it is necessary to open up a reaction tank. This equipment is also part of the lime soda process. This work will usually involve only cleaning out of the tank the deposited solids. Since there is really nothing inside of this equipment that can go wrong, it rarely requires mechanical maintenance. The control valve on the water supply does require attention once in a while, but has been quite free from major difficulties.

Naturally, there are quite a few pumps of one kind or another about a boiler house. All of these units will require a certain amount of maintenance from time to time. There are a few, the importance of which is such that they must be kept in as near to perfect condition as possible. The feed water pumps which supply water to the operating boilers come in this category. Since these units are multi-stage, high-pressure, centrifugal pumps, any wear of the impellers and seal rings will have a detrimental effect on the pumping capacity. When a pump is not delivering sufficient water or develops excessive vibration under normal loads, plans are made to replace the impeller wheels and shaft complete with bearings. This completely built-up replacement shaft is made ready before dismantling the pump, and this procedure reduces the time that the unit is out of service.

Because of the urgent need for these pumps and reasonable assurance of availability for service at all times, it is felt to be poor economy to re-use old ball bearings, regardless of their apparent good condition. A bearing failure could jeopardize production too much to be justified by the small savings obtained from this source.

During the past few years, it has been quite a problem to keep equipment operating in the condition one would like to see it kept. Shortages of both materials and men have kept the operating and maintenance forces on edge. Many times it was "touch and go" whether the units being repaired would be ready for service before some other piece of equipment required immediate attention. However, cooperation between operating and maintenance groups has kept this department functioning up to capacity during this period just as the story has been repeated in practically all industrial plants throughout the country.

Industrial Housekeeping

. . . . good plant housekeeping is the foundation upon which any plant maintenance program must be laid . . . .

By HOWARD S. NOLING

Plant Engineering Department

Rotary Electric Steel Company

Detroit, Michigan

▲ SOME people may ask, "What is the purpose of an industrial housekeeping program, what is the necessity for spending good money to promote order and cleanliness throughout a plant?" The answer is that good housekeeping has three objectives: first, to eliminate accident and fire hazards; second, to conserve space, material, time and effort; and third, to improve employee morale. Experience has proven that these objectives are realized and that the promotion of safety, the increasing of efficiency, and the building of morale increase the company's profits and thereby justify the expenditures made in achieving good housekeeping. My purpose in this paper, however, is not to justify good housekeeping but rather to point out how it may be accomplished.

While any program for the maintenance of good housekeeping and of good sanitary conditions in an industrial plant must necessarily vary with the size of the plant and with the internal organization, it must first be recognized that a good housekeeping program is essentially a program of education. The beginning of such a program rests with the management. Noteworthy success cannot be attained unless the management first educates itself and adopts for itself a high standard and shows continually by its attitude and interest that a definite measure of accomplishment is looked for from every department. But good housekeeping cannot be achieved simply by an attitude of mind on the part of management. Good housekeeping in the plant differs little from good housekeeping in the home, and the old adage we learned from our grandmothers, "a place for everything, and everything in its place" applies to the plant equally as well as to the home. Management must provide the "place" and if it fails to do so, the employee will find it impossible to follow any program, no matter how highly management regards such a program.

Providing the place should be accomplished in the exact sense of the word. The start of a good program consists in the making of an analysis of physical plant facilities and the determination of the adequacy of existing storage space, such as shelves, bins, storerooms, working places and the like. The word "adequacy" should be given careful consideration because while extremely crowded space conditions in a plant inherently make for poor housekeeping, on the other hand, the more floor space there is available, the more the work spreads out thereby creating inefficient operations.

Presented before AISE Detroit District Section Meeting, November 12, 1946

Aisles and passageways should be kept clear at all times for safety of persons walking through. Material should not be allowed to project into aisles, and the aisles should be marked by painted lines.

The place will afford many opportunities for careful thought and not a little bit of ingenuity.

While in this program of education in good housekeeping, management's place is first, that does not mean that the individual employee is unimportant. On the contrary, his part is continuously important. If we have the proper place for everything, we must see that everything is in its place. In carrying out this part of our program we will start with the supervisors and the foremen. They must not only keep the program going by their good example, but they must impress the individual employee with his individual responsibility for good housekeeping. Foremen can set good examples by keeping their own offices and working places in good order. An ill-kept departmental office will generally be reflected by similar conditions in the department. A foreman should have a specific place for all materials and tools and insist upon their being kept in the designated locations. The foreman is the coordinating agency between management and the individual employee in the housekeeping program.

Keeping an entire plant neat and clean is not something that any one man or any one department can accomplish alone. While all employees must be imbued with the importance of the job and taught how to do it, nevertheless a larger portion of the responsibility will fall upon those charged with maintenance. This follows from the very nature of maintenance; appearance and performance both come under good housekeeping. A mechanic really interested in his work will take as much pride in the appearance of the equipment assigned to him as in its performance, and he will be as alert in housekeeping as he is in the maintenance of his equipment. Housekeeping should be a part of the repair job inspection routine of the maintenance foreman. Training of maintenance employees in housekeeping is just as essential as training them in repair work, and every new maintenance employee should be trained so that good housekeeping will become a standard procedure in all his repair work. While some feel that housekeeping can be carried to the point where there will be no maintenance, it is my own opinion that there is no perfect maintenance without good housekeeping.

One of the problems of housekeeping is what is to be done with the old or worn parts removed from a machine. Leaving them spread around on the floor near the machine from which they were removed certainly is not conducive to good housekeeping. I believe that they should be removed at once and inspected to ascertain if they can be repaired for future use. If they cannot, they should be removed to a scrap yard for old parts.

Spare parts are another problem. Where should they be stored? Should they be kept in the department where they are to be used or should they be kept in one centrally located storeroom? When they are kept in the department it is easy to have a duplication of spares. However, regardless of where they are kept, spare parts require exceptional care, not only while they are being handled but also while they are in storage that they may be kept in serviceable condition when required. Spare parts such as armatures and motors should be kept completely covered to protect them against dirt and damage.

While education in housekeeping is important, it is equally important that the employees do not forget what they have been taught. We have said that the first of the objectives of housekeeping is safety. We do not want any employee injured in the performance of his duty. We must have and should enforce rigid rules of safety. Frequent meetings for instruction in safety should be held. Each crew of maintenance workmen should have one of the workmen appointed as a safety observer, who during the course of his work will observe his fellows in their work and who will stop any practice which might be regarded as unsafe. Frequent inspections should be made of a workman's tools by his foreman to see that the tools are kept in first class condition. Electrical foremen and electricians should realize that cleanliness of electrical apparatus is of vital importance to good housekeeping and safety. Especial attention should be given to motors, switch boxes, and control panels. All electrical equipment should be kept free from the accumulation of lint and dust around oil and other combustible materials, particularly with the old style open-end motors, of which we have many in service. The blowing-out, wiping and cleaning of windings and frames should be the regular order of work. The use of sawdust or sand to soak up oil drippings is not good housekeeping, that is merely covering up the mess. Containers for oily rags should be placed conveniently throughout the plant, and in the interest of cleanliness and fire prevention, rags, waste and papers should be removed from under benches, radiators, pipings and other isolated locations. Overhead crane bridges and walkways should be inspected regularly by the foreman to see that they are kept clean and clear of oily rags or other things which might fall and injure men working below.

Aisles and passageways should be kept clear at all times for the safety of persons walking through. Materials should not be allowed to project into the aisles, and the aisles should be clearly marked off either by painted lines or by some kind of well marked curbing. While good housekeeping can be achieved by regular routine and by good example, interest can be maintained by other means of which four may be mentioned:

1. Daily inspection trips through the plant by members of the superintendent's department.
2. Sunday or week-end inspections by selected groups of employees or supervisors.
3. Monthly inspection trips by safety inspectors together with department foremen.
4. Contest. The promotion of a competitive spirit among the employees should be an important means of keeping an interest in the housekeeping program. This method provides a means of recognition of individuals or departments which show exceptionally good records.

   Tangible awards or recognitions to individuals and departments promote good-will and cooperation on the part of the employees.

In writing this paper, the author had in mind the creation of an interest in industrial housekeeping, the stimulation of discussion and the exchange of ideas upon that vital subject, but does not want to convey the impression that everything which was discussed or recommended has been put into practice in his own plant.

A MECHANICAL METHOD FOR *Machine Repair*

. . . . a new method for repairing castings which enables repairs to be made, without distortion and without patches, has been recently developed . . . . such work can often be done without disassembling the machine . . . .

By T. O. OLIVER, JR.
Canadian Representative
Metalock Repair Service
Long Island City, New York

▲ THE repair of cast iron by welding has not been entirely satisfactory for a number of reasons. The application of heat to cast iron, particularly in the case of machine frames, not only disturbs the structure of the iron itself, but results in distortion that necessitates normalizing and re-machining in order to restore original alignment. In many cases dismantling is necessary to effect a welded repair and usually dismantling and reassembling are costly both in time and in money.

The repair of castings by this process has been developed over the past 11 or 12 years and is becoming widely accepted in both light and heavy industry as a most economical and highly expeditious method.

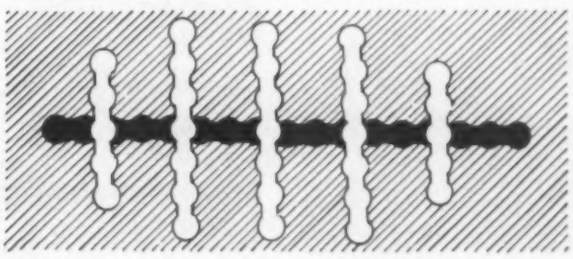
In many instances castings do not fail or break as a result of over-loading of the machine but fail due to inherent stresses or strains that occur in the pouring or cooling of a casting that has varying degrees of density within its pattern or shape. These cracks, when due to this cause, provide a stress relief and the advantages of allowing this stress relief to remain are quite obvious as long as it does not have any serious effect on the alignment of the equipment in question. To repair such a crack by welding or any other method that employs heat has a serious effect on the structure of the cast iron itself, and while it may not again break where the actual fracture originally occurred, it will frequently fail somewhere in the area where the heat was applied. Our process, being cold, eliminates this difficulty and allows the relief to remain in the casting; which, if the strength can be restored, leaves the casting better than a new one, as the weak spot has been found and something constructive has been done about it.

The theory and practical application of the process entails the insertion of a prefabricated specially designed alloy lock of precise dimension into a prepared aperture in the parent metal. This special alloy lock is made in various lengths, widths and thicknesses. These thicknesses or depths range from $\frac{1}{8}$ to $\frac{5}{16}$ of an inch and the width is about the same as the thickness. Depending upon the depth of the crack and the thickness of the casting, we determine how many of these locks must be inserted to restore the original strength to the casting. You can appreciate that the strength of the alloy used is far in excess of that of cast iron or cast steel, and when properly computed, the original strength plus the safety factor can be put back into the casting.

These prepared apertures transverse the crack at right angles and in the case of a complete break, the casting is clamped securely together before any locks are inserted.

The apertures are intentionally prepared slightly smaller than the lock that they are to accommodate, and the lock itself is driven in with an air hammer and shears its way to the bottom of the aperture or slot. The side walls of these apertures are perpendicular, but small anchor holes are drilled at 45 degree angles at the bottom of the slot so that when the lock itself is driven

Figure 1 — Specially formed locks or keys are used to splice cracks in castings. The slots are cut transverse to the fracture and the locks are inlaid by cold working into the parent metal.



Presented before AISE Buffalo District Section Meeting, April 9, 1946

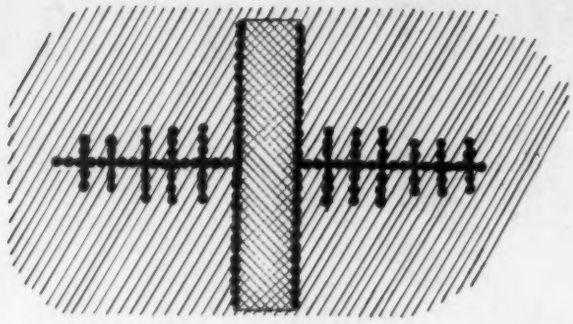


Figure 2 — At points of high stress concentration, an inlay of high strength alloy plates may be used. These are held in place by dowels cold worked into matching half holes between the parent metal and the lock.

home, it has room to flow under the working of the hammer and thus give better grip. As each lock is inserted, and individually processed, the anchor holes are drilled immediately above it so that the subsequent lock may receive the same grip as the previous one. This process is repeated until the aperture, which may be 2 or 3 inches deep, or even deeper, is completely full of material and after the processing of these locks under the hammer they become work hardened to the point where it is exceedingly difficult to drill them with an ordinary high speed drill.

From the foregoing, it will be appreciated that the material is highly ductile. It is actually about 65 per cent steel and approximately 35 per cent nickel; it has a high resistance to heat and impact, and will not rust. It has great strength and elasticity, and has a low coefficient of expansion.

To return to the actual practical application to a broken casting, after the locks have been applied across the crack at anything from ¾ to 1½ in. centers, as well as 1 in. beyond both extremities of the crack to prevent a continuation of the break or crack, we then put these locks in tension by inserting threaded lock material to the same depth as the locks but along and within the fracture itself. The holes to accommodate this studding are usually the same diameter as the radius section of the lock itself and are drilled contiguous so that when the crack has been completely studded from one end to the other and peened, there is solid material along the actual fracture.

It is well to study just how the apertures are developed. To begin with, the number of lugs which is the term used to designate the radius section of the lock, depends upon the amount of strength that is necessary to restore and also to some degree on the quality of the parent metal immediately adjacent to the crack and into which these locks must be imbedded. Inasmuch as the lock material is available in lengths up to 24 in. or more, it can be sheared to the desired length. The first step is the laying out of the location of all locks that are to be used in the repair and this is done by template; and equal numbers of lugs are left on either side of the crack. These templates will accommodate a fine pin-punch for the purpose of locating the hole. The holes are then drilled with a pilot drill by the use of a jig. The template is then removed, the hole is reamed to the required size, and by the use of a special splitting tool the remaining webs between the holes are split out.

It is a rather highly skilled operation to apply the

Figure 3 — On left is shown a 10,000 kw steam turbine casing wrecked by an internal explosion, and on the right is shown the same casing after being repaired.

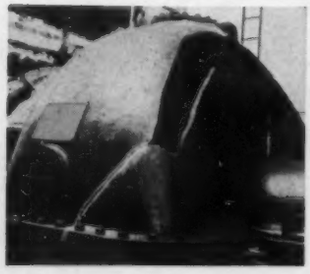


Figure 4 — Shown above is a broken frame for a 250 ton press in process of repair.

Figure 5 — An interlocking inlay is installed flush with the parent metal and another is inserted and about to be locked in.

process properly and it is, therefore, impractical and uneconomical for any one industry to train their own men for this purpose. Like many other operations where the human element is a cogent factor, it can be said that the success or failure of such repairs is to a large degree contingent upon the conscience of the operator.

Up to this point, nothing has been said about "Masterlocks" which term is used to designate steel sections that are applied in the case where tensile strength is of prime importance. They are usually of high grade machinery steel and are more often than not rectangular in shape. The thickness of this lock is determined by the depth of the parent metal and the amount of strength required to be restored to the casting. The lock is imbedded in the parent metal up to a depth of 3 in. and is finished off flush with the adjacent parent metal. When the aperture is created to accommodate the Masterlock a series of half holes up to 5/16 in. in diameter is left around the perimeter of the aperture and a series of half holes is left around the perimeter of the Masterlock so that when inserted, a series of complete 5/16 in. holes is left to accommodate the anchoring material used around the perimeter.

In some cases where the Masterlock is rather large, "bosses" or projections of parent metal are left within the aperture, which is to accommodate the lock, and accommodating holes are prepared in the lock, all of which have the aforementioned series of half holes around the perimeter in order to provide greater contact with the parent metal, and thus give further protection against buckling which might occur under the terrific compression strain that is set-up when the material is processed around the outer dimensions. It is only in unusual cases that "Metalocks" are used to hold a "Masterlock" in place.

It can be appreciated that there are combinations of "Masterlock," "Metalock" and "Metalace" that will solve a repair problem of almost any kind. It can also be seen that combinations can be developed to reinforce new equipment that might be subject to unavoidable overload in the normal function of the machine. In our experience we have successfully worked against pressures of 5000 psi by a combination.

DISCUSSION

PRESENTED BY

A. J. F. MacQUEEN, Mechanical and Electrical Superintendent, Atlas Steels, Ltd., Welland, Ontario, Canada

T. O. OLIVER, JR., Canadian Representative, Metalock Repair Service, Long Island City, New York

C. J. PORTER, Electrical Engineer, Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

H. R. TURNER, Superintendent Mechanical Department, Bethlehem Steel Company, Lackawanna, New York

H. E. DAVIS, Superintendent of Maintenance, Republic Steel Corporation, Buffalo, New York

JOHN E. SOWERS, JR., General Electrical Foreman, Bethlehem Steel Company, Lackawanna, New York

A. J. F. MacQueen: We have had some experience with Mr. Oliver's process in our plant, and have repaired some cracks that developed in parts of our forging hammers quite successfully with this method.

I am also going to mention another job we did that was not so successful. It illustrates that the human element is quite an important factor in the proper performance of the repairs.

The job that didn't turn out so successfully was planned properly, and the proper materials were used. The workmanship was a little at fault, and this made the difference between success and failure.

I would like to ask what Mr. Oliver would consider the minimum time to train a man to make proper repairs, and I would also like to know if there are any others who do that.

T. O. Oliver, Jr.: When we take a man in, he is a man we have investigated very carefully to see if he wants to make a career of our work and if he is a man who has mechanical instinct and ability. We can tell in about four or five weeks if he will make such a man, and we will tell him at the end of five weeks or less whether he has made a good try and whether he should continue with it. Usually a man can go out with the men we have in our shop. We do a lot of work on location. After a man has worked two or three months in the shop, he can go out and do jobs and answer the questions of employees and engineers who may be interested. He is usually with a helper, but later at the end of about four months, he is ready to go on his own for the simple jobs. It takes quite a bit of ingenuity at times to know how repairs should be made.

There is no other organization which does this work.

Member: Could you give me the strength of the material?

T. O. Oliver, Jr.: The strength would vary with the grade of steel you use. All of the "Metalock" is around 120,000 psi. We usually allow ourselves a little safety factor where a guarantee is involved, but we can stretch it out to that without much trouble.

C. J. Porter: Early in your paper, you referred to the process as applied to cast iron castings. Do you apply it only to cast iron?

T. O. Oliver, Jr.: No. We do work in cast steel, but are very careful to obtain a careful analysis of the steel before we do anything with that.

H. R. Turner: At some time, most people in a steel plant are faced with the problem of repairing castings, iron castings particularly. We are all liable to lay the blame on the operator for overloading the machine, when really it may go back to the making of the casting

in the factory. The operation of fixing breaks has never been an exact science.

In the past, we have been faced with three possibilities when we have a failure: One, throw the piece out and get a new one, which has been difficult in the last few years. Another method is to use a mechanical patch, which we all try to do. This method has not been very satisfactory in appearance or effectiveness.

I think the means which has been described in this paper will have a big field in correcting the trouble. I know my experience in the past has been that we get a cast iron crane in operation, the crane runs for several years, and the first thing you know you have a big crack in cast iron end carriage. You look it over to see what can be done. Finally you drill enough holes in it to put on a patch, which further weakens the casting and there is a possibility of it breaking again. A very effective method has been introduced for correcting this condition.

H. E. Davis: We were up against a problem on the repairs to a diesel locomotive where the amount of damage to the unit was such that repairs seemed impossible, and replacement of the unit would necessitate laying up the locomotive for several months on account of delivery of a new unit. Mr. Oliver's company had previously completed a small job for us so we called them in to see what they could do on the diesel unit and were happy to hear that they could repair the unit. Since that time we have had them do a job on a cracked water jacket of a 2500 cu ft air compressor. From our experience, we feel that we can make repairs on some jobs now that appeared beyond repairs before trying out this method.

John E. Sowers, Jr.: I would like to ask how the method would stand up in the repair of an iron casting that is exposed to high temperatures.

T. O. Oliver, Jr.: We have used it successfully in not too excessive temperatures. How high a temperature would you have in mind?

John E. Sowers, Jr.: I had in mind some furnace doors, which are cast iron frame, lined with brick. They were always a source of trouble to try to keep together.

T. O. Oliver, Jr.: The actual cast iron frame is not exposed to excessive temperatures, since they are not exposed to flowing metal to burn them out. The temperatures would run to what value?

John E. Sowers, Jr.: 1400 or 1500 degrees.

T. O. Oliver, Jr.: You are getting pretty close to the ceiling for our material at that temperature.

RECLAIMING A BROKEN 54 IN. MILL PINION

. . . . it is often more difficult to make a decision to repair an item beyond the range of those previously attempted than it is to do the actual job itself . . . .

By WARREN W. SCHERER
Superintendent of Maintenance
Carnegie-Illinois Steel Corporation
Homestead, Pennsylvania

▲ THE rehabilitation of broken roll and pinion wobblers, universal couplings, mill spindles, etc. has been more or less routine at Homestead works for a number of years, using the thermit welding process.

Recently one of the mill drive pinions in service on the 54 in. blooming mill broke through the toothed section after several years of continuous service. Ordinarily, any idea of attempting to reclaim the pinion for future service would have been considered impractical and the pieces consigned to scrap. In this instance, however, because of the particularly regular nature of the fracture, the maintenance department decided that the possibility of successful reclamation was good, and that the project could be justified economically. Plans were made accordingly and the necessary equipment and materials procured.

This particular application is considered to be of interest because of the massiveness of the weld and the accuracy of alignment required for successful completion. It is believed to be the largest such weld ever attempted.

This pinion, the top one of a set of two that drives the 54 in. blooming mill, is of the double helical type, having a pitch diameter of 54 in., a circular pitch of 9.425 in. and eighteen 20 degree involute machine moulded teeth, a face width of 72 in., and a total weight of 82,000 pounds. The fracture occurred at a point approximately 3 in. from the apex of the teeth on a practically flat plane perpendicular to the rotational axis of the pinion. There being no evidence of

Presented before AISE Pittsburgh District Section Meeting, April 14, 1947

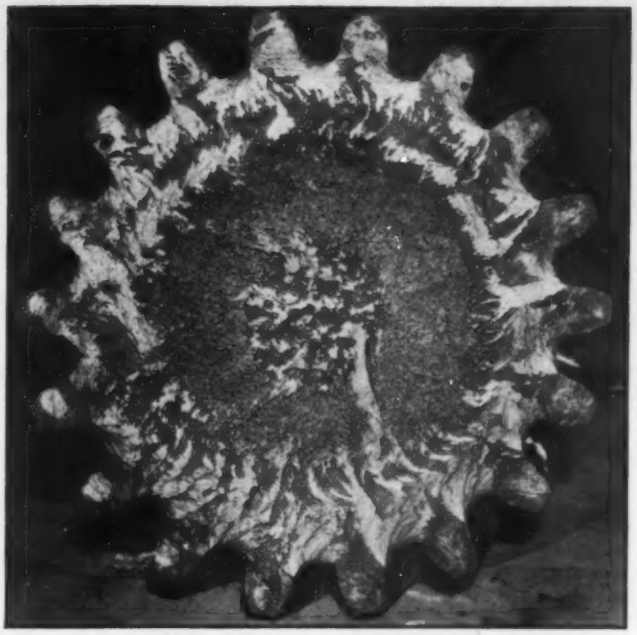


Figure 1 — Photograph of fracture through 54 in. mill pinion.

crack progression, it is believed that the pinion broke as the result of a shock load. The fracture is shown in Figure 1.

In preparing the pinion for welding, both fractured faces were machined to provide a parallel gap 3¼ in. wide to receive the molten weld metal. A 2½ in. diameter hole was drilled in the exact center of both faces for a centering pin. The teeth were further machined off for a short distance beginning at the fractured and subsequently machined surfaces to insure ample heat for complete fusion at the circumferential surface of the body proper. Finally these surfaces, except for four

Figure 2 — The ends of the broken gear were prepared for welding by torch scarfing.

Figure 3 — A temporary setup was made for checking measurements.

small, equally spaced radial areas and the area surrounding the centering pin, were torch scarfed. The purpose of scarfing was to provide a relatively tight oxide surface as a protection against excessive scaling during preheating for welding. The small unscarfed surfaces provided a seat for spacer blocks which were tack welded in place at the time the pinion was set up for welding. Figure 2 shows the prepared surfaces. Figure 3, showing a temporary setup for checking measurements, provides a good view of the gap.

The assembly was set up on improvised vee blocks,

Figure 4 — The entire body of the pinion was encased in a mold box.

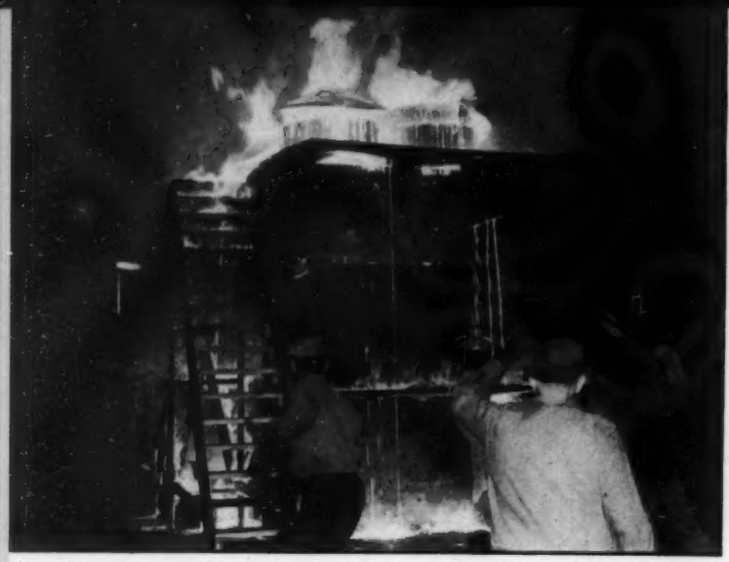


Figure 5 — The reaction in the crucibles was quite spectacular.

in turn supported by a rigid cast iron surface plate, and lined and leveled throughout with level and surface gage. As a further aid, the civil engineers set up permanent targets whereby checks could be made on the alignment at various intervals during the preheating and cooling down stages. A flanged, sheet metal, sectional mold was fitted around the gap and adjacent tooth sections and filled with wax. The wax was then shaped to minimize stock removal in recutting of teeth in the welded section of the pinion.

A mold box, 60 in. wide, 96 in. long and 112 in. high was constructed of $\frac{5}{8}$ in. gage plate to encase the entire body of the pinion. Appropriate sized rounds were positioned in this box to provide four suitable pouring gates, three risers (one 6 and two 4 in.), and the necessary openings for admitting preheating burners and withdrawal of the wax, Figure 5.

In order to support the four crucibles, a steel platform was erected over the entire mold. A 2 in. thick plate with four openings to support the four No. 15 crucibles formed the top of the platform. In addition, wing plates were placed on two sides to protect workmen from molten splash. In order to accommodate the required weld material in each crucible, namely, 2350 pounds, it was necessary to add 22 in. high extension rings to the largest available crucible, No. 15, which normally holds 1200 pounds.

The journals were enclosed in temporary improvised brick furnaces to facilitate heating of the body proper. These were removed prior to tapping. The oil burners used to heat the body were on blast for 36 hours, after which time an optical reading of 1950 F was obtained on the surfaces at the gap.

The four crucibles were ignited simultaneously. The reaction was quite spectacular, it being necessary to wait several minutes for the turbulence to subside before tapping. Tapping was also simultaneous or as nearly so as conditions permitted.

After pouring, the enclosed pinion was permitted to cool undisturbed. It was stripped twelve days later, and all risers and feeders were removed by flame cutting and the flame cut areas locally stress relieved. Figure 5 shows the reaction in the crucibles and pouring at different stages. Figure 6 shows the pinion upon removal from the mold.

Figure 7 — A light cut over all the teeth was the last operation in the repair.

Figure 6 — Welded pinion as removed from the mold.

When the pinion was set up in a lathe it was found that the maximum deviation from true alignment was 0.029 in. which is considered to be remarkable for an undertaking of this nature and size. This was corrected by taking a light cut from one of the journals. The amount of undersize as the result of this cut was so slight that no corresponding adjustment in the babbitt bearings was considered necessary. While set up in the lathe, the surface of the weld was turned to the adjacent diameter and the pinion transferred to a gear planer. A light cut was taken over the entire profile of all teeth. Figure 7 shows the recut pinion.

A special high carbon weld metal was used in order

	Carbon	Manganese	Phosphorous	Sulphur	Silicon
Pinion	0.69	0.56	0.034	0.036	0.21
Weld	0.50	0.95	0.018	0.029	0.39

to approximate the chemistry of the pinion. Analyses of the pinion and of the weld are shown in table above.

Materials required for this undertaking include:

1. 96 barrels thermit mold sand.
2. 9400 lb special thermit.
3. 815 lb molding wax.
4. 385 gallons kerosene.

These items are in addition to the steel shapes and plates, brick, etc. required for the temporary structures.

The repaired pinion was reinstalled October 27, 1946, and up to the present time it has been giving satisfactory service. It is reasonable to assume that it will continue in operation for many years and, if so, the decision to attempt this repair will have been amply justified.

DISCUSSION

PRESENTED BY

WARREN W. SCHERER, Superintendent of Maintenance, Carnegie-Illinois Steel Corporation, Homestead, Pennsylvania

E. W. TREXLER, Superintendent, Mechanical Department, Bethlehem Steel Company, Johnstown, Pennsylvania

J. M. WILSON, District Engineer, Metal and Thermit Corporation, Pittsburgh, Pennsylvania

Member: What was the comparative reclamation cost compared to a new pinion?

Warren W. Scherer: A saving of more than 60 to 70 per cent. When you are talking about a pinion like that you are talking about $23,000 to $25,000 item roughly speaking.

E. W. Trexler: Did you attempt to stress relieve the whole pinion?

Warren W. Scherer: No.

J. M. Wilson: The weld is automatically stress relieved during its making; there are no stresses within the weld.

E. W. Trexler: You said that you attempted to stress relieve the risers. How did you do that?

Warren W. Scherer: We did that with torches which were used to remove the risers. The cutting was done while there was some heat left in the casting; and, as an extra precaution against cracking and to insure machinability, a flame was played on the cut surfaces for several minutes.

ORDERING RENEWAL PARTS FOR MOTOR CONTROL

. . . . proper procedure in ordering spare parts will expedite delivery of the order, and ensure that the correct part is received . . . .

By O. P. ROBINSON

Cutler-Hammer, Inc.

Pittsburgh, Pennsylvania

▲ THE ordering of renewal parts for motor control is important to both the user and the supplier for two reasons. One reason is to be assured of getting the correct parts, and the second reason is the saving of time and correspondence.

Without having the correct information on the order, it is difficult for a manufacturer to recognize the part required, and requires his searching through old records and renewal part sheets, sometimes for days, before the correct interpretation of the customer's order is obtained. In many cases this involves the exchange of letters, sometimes three or four in each direction. In these days of shortages of competent clerical help and high costs, added burdens are applied to both the customer and the supplier in filling these orders. Most people recognize that it costs money to write letters, to say nothing of the time lost in getting the order into production by long interchanges of correspondence and searching of old records. This can all be eliminated by proper identification of parts required when ordering, and care in copying down numbers and letters on renewal parts.

In the course of a normal day, in orders for renewal parts we get many orders with incorrect serial numbers, incorrect prefix and suffix letters, and many orders are received in which no identification at all is provided, the order merely calling for parts by description, with no ratings, voltages, number of poles, or any other information which would enable the manufacturer to tie down the required parts.

Presented before AISE Pittsburgh District Section Meeting, April 14, 1947

RENEWAL PARTS SUMMARY

FOR

Reversing - Non Plugging Mill Controller

DWL. NO. 14010

C-H SERIAL NO.

MACHINE NO. [redacted]

APPLICATION Bar Straightener SHEET NO.

HP. 125 VOLTS 230 AMPS. PHASES CYCLES DC DATE 6/14/47

EQUIPMENT		WIRING DIAGRAMS	INSTRUCTION SHEETS	DIMENSION DRAWINGS
CONTROL PANEL		112661D3	Below	A39-936
Operation and Adjustment for Ltl Cont.			5963	
ARMATURE RESISTOR (5 - M 52 boxes)		112662D1		
ACCESSORIES	**TYPE**			
Rheostat			B70-118	A82-436
Master			7148	A83-119(Sch
P.S. Station	Bul. 1028CH1014A (1 el.		7407	C86-494 P.4

DIAGRAM MARKING OF DEVICE	DEVICE NO.	FUNCTION	INSTRUCT. SHEETS	OPERATING COIL NO.	DISCHARGE COIL NO.
1F	131	Relay	941	231-5	
1FD	131	Relay (series)	941	202-1	
1FD	131	Relay (shunt)	941	61-1	
UV	369	Contactor	7322	483-7	529-8
2FA	369	Contactor	7322	483-7	529-2
DF	369	Contactor	7322	483-7	
1F-2F-1R-2R	545	Contactor	7411	96-11	
2FD	560	Contactor	7412	91-13	476-4
DB	565	Contactor	7413	66-9	
1A-2A-3A	575	Contactor (close)	7415	95-11	
1A-2A-3A	575	Contactor (hold)	7415	1083-1	
M	575	Contactor (close)	7415	95-11	
M	575	Contactor (hold)	7415	494-8	
1FL	131	Relay	941	91-87	18-18
10L-20L	609	Overload	7235	179-20	
Knife Switches					
1 KS		1-600a. 250v. 2 PST	6497		
2 KS		1-600a. 250v. 2 PST	6497		
Fuses		2-15a. 250v. pt.#44-637			

Figure 1 — A renewal parts summary sheet carries complete information on the item.

All electrical control manufacturers have available renewal part information on every piece of apparatus they make, and each man charged with the responsibility of maintaining equipment and also those whose duty it is to maintain renewal part stocks in store room, should see that they have on file the renewal part data on all equipment in their plant. No charge is made by any of the control manufacturers for this information and they are only too glad to furnish it because it helps cut costs in the handling of the order.

Most control manufacturers have their renewal part sheets made up on the basis of devices, such as contactors, overload relays, control relays, because these same devices are used on hundreds of different types of controls, and the renewal part information on any particular controller will consist of several renewal part sheets, all covering the various devices on the panel. In many cases, special devices are provided on panels, and these are covered by renewal parts drawings which identify the parts used. Usually these sheets show the number of parts used on the device, and recommend spares list, to be carried in stock as replacements. These consist of parts such as contact tips and springs which must be renewed fairly often.

In addition to the above, engineering data sheets are provided by some manufacturers, and these sheets are very valuable to engineering departments and maintenance departments, as well as stores departments. These engineering data sheets contain all of the data on the resistor layouts, type and size of grids, wiring diagram numbers, coil numbers, resistor values and identifying numbers, as well as giving the number of the part sheet applied to the different devices. Blowout coil numbers are also included on these engineering data sheets, and ordering information on material which the control manufacturers purchase from others, such as circuit breakers, indicating lights, etc. These engineering data sheets give the device number, so that in later years, if the renewal part sheet has become lost or worn to such an extent that it can no longer be read, the customer can go to the engineering data sheet and pick out the device, together with the number of the part sheet and reorder. Bear in mind that new part sheets are supplied free of charge upon request, and a number of these part sheets should be made available to those people who are responsible for the requisitioning of renewal parts.

Figure 1 is an example of such a data sheet. Note the completeness of the information supplied. The serial number of the equipment is given, as well as the horsepower and power characteristics and the name of the drive.

Under this is given the wiring diagram and dimension drawing reference, and the drawing number showing the resistor layout. This resistor drawing gives the number, type and size of each grid, and the total ohms per step and box, and number of boxes. All of these drawings are bound in the renewal parts book with the renewal part sheets, Figure 2. Next, each device on the panel, with the correct manufacturer's identifying data is given, just as it is identified on the wiring diagram, and the renewal part sheet which applies is given, and also the operating coil numbers. With this information, spares can be ordered correctly and easily.

Usually on controls involving several devices, renewal part booklets are made up which contain the engineering data sheets, renewal part sheets, wiring diagrams, dimension drawings and resistor layout drawings. These can be kept on file at the plant as a master reference, when required.

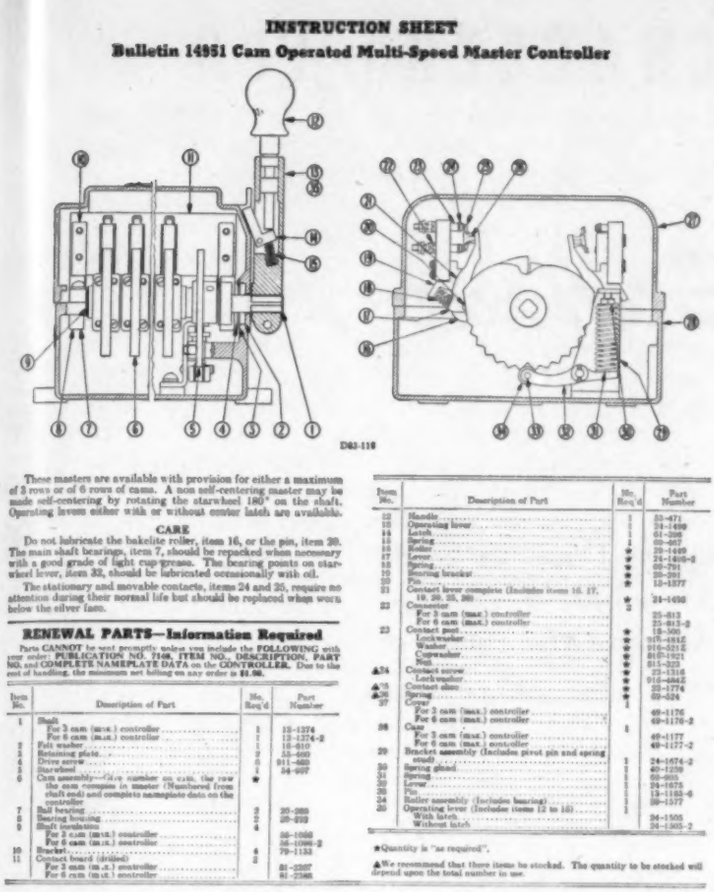
If renewal parts are to be properly ordered, and to be properly received, then it is important to keep a complete file of information. Sometimes this is done on a card system when new motors and controls are recorded, with the complete nameplate data so that this information is always available. We have had hundreds of cases where nameplates have been missing from the panels, and card files or renewal part files on these equipments then become invaluable.

Because of the fact that so many nameplates are removed or obliterated, you can see it is important to gather this information when the equipment is first received, so that it does not become lost.

Practically all manufacturers use a system of serial numbers or bulletin numbers, the serial number being more popular on large panel jobs, while bulletin numbers are used frequently on standard goods such as pushbuttons and across-the-line starters. These serial numbers or bulletin numbers are very important, because the manufacturers identify the part sheets, wiring diagrams, etc., from them and the records are kept on this basis.

All operating coils usually have a metal tag taped into the taping of coils, and this coil number identifies the coil. Resistor units have much the same identifying marks, and a record should be kept of these also.

In properly ordering renewal parts, therefore, one



INSTRUCTION SHEET

Bulletin 14951 Cam Operated Multi-Speed Master Controller

D62-110

These masters are available with provision for either a maximum of 3 rows or of 6 rows of cams. A non self-centering master may be made self-centering by rotating the starwheel 180° on the shaft. Operating levers either with or without center latch are available.

CARE

Do not lubricate the bakelite roller, item 16, or the pin, item 20. The main shaft bearings, item 7, should be repacked when necessary with a good grade of light cup grease. The bearing points on starwheel lever, item 32, should be lubricated occasionally with oil.

The stationary and movable contacts, items 24 and 25, require no attention during their normal life but should be replaced when worn below the silver line.

RENEWAL PARTS—Information Required

Parts CANNOT be sent promptly unless you include the FOLLOWING with your order: PUBLICATION NO. 7168, ITEM NO., DESCRIPTION, PART NO. and COMPLETE NAMEPLATE DATA on the CONTROLLER. Due to the cost of handling, the minimum net billing on any order is $1.50.

Item No.	Description of Part	No. Req'd	Part Number
1	Shaft		
	For 3 cam (max.) controller	1	13-1374
	For 6 cam (max.) controller	1	13-1374-2
2	Felt washer	2	41-610
3	Retaining plate	2	55-660
4	Drive screw	2	911-660
5	Starwheel	1	34-607
6	Cam assembly—Give number on cam, the row the cam occupies in master (Numbered from shaft end) and complete nameplate data on the controller	*	
7	Ball bearing	2	20-260
8	Bearing housing	2	20-259
9	Shaft complete	1	
	For 3 cam (max.) controller		35-1060
	For 6 cam (max.) controller		35-1060-2
10	Bracket	1	79-1133
11	Contact board (stud)	2	
	For 3 cam (max.) controller		81-2367
	For 6 cam (max.) controller		81-2368

Item No.	Description of Part	No. Req'd	Part Number
12	Handle	1	53-471
13	Operating lever	1	34-1499
14	Latch	1	61-3005
15	Spring	1	69-467
16	Roller	*	20-1499
17	Lever	*	34-1496-2
18	Spring	*	69-791
19	Bearing bracket	*	35-261
20	Pin	*	13-1377
21	Contact lever complete (Includes items 16, 17, 19, 20, 23, 30)	*	34-1498
22	Connector	2	
	For 3 cam (max.) controller		25-613
	For 6 cam (max.) controller		25-613-2
23	Contact pad		18-501
	Lockwasher	*	916-481Z
	Washer	*	916-521Z
	Coppersher	*	810-1921
	Nut	*	815-523
▲24	Contact screw	*	23-1316
	Lockwasher	*	916-6042
▲25	Contact shoe	*	22-1774
▲26	Spring	*	69-524
27	Cover	1	
	For 3 cam (max.) controller		69-1176
	For 6 cam (max.) controller		69-1176-2
28	Cam	1	
	For 3 cam (max.) controller		69-1177
	For 6 cam (max.) controller		69-1177-2
29	Bracket assembly (Includes pivot pin and spring stud)	1	24-1674-2
30	Spring gland	1	40-1259
31	Spring	1	69-603
32	Lever	1	24-1675
33	Pin	1	13-1133-6
34	Roller assembly (Includes bearing)	1	20-1377
35	Operating lever (Includes items 12 to 16)		
	With latch		34-1505
	Without latch		34-1505-2

*Quantity is "as required".

▲We recommend that these items be stocked. The quantity to be stocked will depend upon the total number in use.

Figure 2 — An example of the detailed parts data sheet as it should be bound in the renewal parts book.

should give the bulletin or serial number of the complete control and the part number wanted, together with reference to the part sheet number and item from which it was selected. In this way, numbers which have been incorrectly transcribed can be corrected by people who edit your order, by referring to the part sheet and item number.

You should also keep renewal part items on separate orders from complete control apparatus, because usually the orders are filled in different parts of the plant, and are handled entirely differently.

Renewal parts should be ordered from the original manufacturer of the equipment, because he knows best the tolerances and material of which to make the parts, and one will thus have less trouble in maintaining the equipment. The original manufacturer is responsible for the operation of the equipment for years after its purchase, and troubles on controls are always referred to the original manufacturer. He should, therefore, be given the opportunity of furnishing his own renewal parts, so that he may accept this responsibility.

Finally, since all of the above mentioned is available, the user should examine his files to see that he has it, and in sufficient quantity to enable those charged with the keeping of renewal parts informed on the various manufacturer's methods of handling orders.

Renewal part orders, properly made out with identifying part numbers, renewal part sheet references, and serial numbers go through the factories with no difficulty, and in fast time, thereby giving quicker delivery with less handling, and thus enabling the manufacturer to be of much greater service.

DISCUSSION

PRESENTED BY

E. L. ANDERSON, Electrical Superintendent, Bethlehem Steel Company, Johnstown, Pennsylvania

O. P. ROBINSON, Cutler-Hammer, Inc., Pittsburgh, Pennsylvania

ROBERT WHITEHILL, District Manager, Clark Controller Company, Pittsburgh, Pennsylvania

C. O. FRANKLIN, Electrical Engineer, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania

E. L. Anderson: I know from experience that Mr. Robinson's comments on the handling of spare parts are important. It is very vital to have the proper information, and much time and cross-correspondence can be saved if the right information is given to begin with. There is one thing that often puzzles me. Some of us have equipment that is 15 to 20 years old, and when we order a part for a certain contactor, the manufacturer says, "No, that is no good, I have another part and have assigned another number to it." When you get three or four such items, it is quite a problem. Is there any setup whereby customers are notified of changes when they are made, so the records can be kept up to date and avoid these difficulties?

O. P. Robinson: Yes, there is. On most of the orders on which substitutions are made, your invoice, when it is issued, carries the substituting number, and the invoice is marked that the material being shipped is a substitute and is interchangeable with the previous part that you ordered.

E. L. Anderson: Is the original spare part bulletin ever corrected?

O. P. Robinson: In some cases, the spare part sheets are corrected, if it is a fairly new device. If it is a device ten years or more old, it isn't, because the volume of those orders are dropped off, and finally you get to the point where there are no more for that material in about ten or twelve years.

Robert Whitehill: One point I think might be stressed, as a matter of repetition, and that is to obtain correct serial numbers. In some cases the manufacturers may be at fault on some of the errors. I know some of us use various stamping methods and identification, whereby 6's and 8's look about the same, the manufacturers are then at fault for some of those letters that must be written. We all have a lot to learn about proper identification of serial numbers, because many times they determine the source of correct information for parts.

C. O. Franklin: It was stated that we should obtain a supply of spare part leaflets to assist in ordering spares correctly. One way to be sure of obtaining these leaflets is to include in the specifications for the equipment, a clause to the effect that the desired number of copies of spare parts bulletins shall be furnished, together with wiring diagrams, dimension sheets and other pertinent data.

PACKAGING SUPERCHARGERS FOR

Shipping and Storage

. . . . spare parts and equipment may be kept indefinitely, by enclosing the part in an impervious container and keeping the relative humidity below 30 per cent . . . .

By R. BRUESEWITZ

Assistant Production Control Manager

Allis-Chalmers Manufacturing Company

Milwaukee, Wisconsin

▲ THE problem of preserving metal parts against the ravages of corrosion has existed ever since man first shaped things out of metal. This problem has grown more acute as manufactured finished parts required ever closer dimensional tolerances and increasingly finer finishes. Recent years saw this problem take on major proportions because men's lives and the success of our armed forces depended upon the proper preservation of metal parts against the natural forces of sun, heat, wind, cold, rain, snow, sea water, mist, perspiration, humidity and corrosive fumes. These natural forces are eternally at work attacking, deteriorating, and destroying man-made things whether man is at war or at peace. This attack is unyielding and occurs everywhere to varying degrees whether the location is indoors or outdoors, in Maine or in Mexico.

Only the noble metals, such as gold and platinum, are immune to corrosion. All other commercial metals yield to its attack. Surrender to this corrosive attack by iron and steel is evidenced by the formation of its yellow, orange, red or black oxides, rust. The evidence of attack on copper is its green carbonate, black and varying red oxides, and black sulfides. Zinc and cadmium turn white. The tarnishing of silver and the darkening of nickel, the graying of tin, and the white powdering of aluminum are all types of corrosion that come within the experience of everyone.

The methods and materials used to combat and retard corrosion are as multitudinous as the problem itself. Electroplating with copper, nickel, cadmium, chromium and silver is one method. Anodizing of aluminum is another. Hot dipping, such as galvanizing and immersing in acid manganese phosphate, is still another. Coating with grease or paint is still another, to mention only a few.

The method and material to be used to preserve a part is determined by the considerations of the part itself, such as its kind of metal, finish condition (very fine to very rough), its value, how long and where will it be stored, what forces of attack will it be subjected to, and other questions of like nature. This paper will be confined to a narration of the methods and materials

Presented before AISE Pittsburgh District Section Meeting, April 14, 1947

used at the Allis-Chalmers Supercharger works during the war years.

The products manufactured in this DPC plant during the war years were aircraft superchargers of both the gear driven two-stage, and the gas turbine single-stage type, and a small number of jet propulsion engines. The principal metals used in these products were aluminum, phosphor bronze, conventional SAE aircraft quality steels, and high temperature alloys, such as vitalium, Timken alloy and 18-8. Cadmium, chrome, and zinc-plating were employed on hardware items, and anodizing was done on some aluminum parts. Electroplating was done according to Army-Navy specifications and, consequently, was of a sufficiently corrosion resistant nature to present no further problem. The unplated parts, which were not made of stainless alloys, presented a triple corrosion prevention problem: first, in handling during the machining operations; second, in stores stock awaiting either assembly or direct spare parts shipment; and third, in preparing for shipping.

The problems of handling during manufacture and the preservation of parts in stores stock were the direct responsibility of the manufacturing personnel. The materials used in preparing for shipping, however, including shipping boxes, moisture impervious bags, dehydrating agents, moisture indicators, and other like equipment, were purchased or made to Army-Navy specifications. The sequence of assembly of the various shipping materials was the result of normal production planning. Since the packaged unit was the end result of the entire production program, and also since, to the casual and general observer, the assembly procedure of the shipping materials was by far the most glamorous of the three preservation problems, the paper will begin at this point and work back to the detail parts in process.

The completely assembled turbosupercharger was given a specified performance test. Super-heated steam supplied the motive power during test in place of engine exhaust gas as in the plane itself. Upon completion of the test run, but before the unit was removed from the test stand, the lubricating oil was drained and the unit was flushed internally with a corrosion preventative compound.

Figure 1 — The air-proof and moisture-proof package enables shipment of this engine to any part of the world.

Upon completion of the flushing operation, the unit was given a final visual check by both company and Army Air Forces inspectors for defects of material and workmanship that the performance run might have uncovered. If accepted, the unit passed along the route of a monorail until it reached a point over the shipping assembly roller conveyor. While the turbosupercharger was approaching this point, the base of the shipping box was being readied to receive it. This readying included the treatment of all irons, bolts, nuts, and washers used in this box with a corrosion preventative compound conforming to type I requirement of Army-Navy aeronautical specification AN-C-52. On this base were four brace assemblies to which the supercharger was bolted. A transparent moisture impervious bag made of a rubber hydrochloride, with four integral rubber gaskets spaced to fit over the bolts in the four braces, was then placed over the braces and rolled down in the same manner as a stocking. The supercharger was placed on the braces and fastened, sacks containing a dehydrating agent (either silica-gel or desiccite) were tied to the sides of the supercharger, and a humidity indicator attached so as to be clearly visible through the inspection hole in one of the panels of the box. This done, the assembly was rolled under a sealing machine which was placed on a track over the conveyor and parallel to it. The moisture impervious bag, which had the shape of a large pillow case, was next drawn up over the unit and the corners of the open end were gripped by clips, one fixed and one movable and spring loaded, thus bringing the two sides of the bag close together. Between these two sheets and at the far corner, a flat nosed attachment of a vacuum cleaner was inserted by which the air in the bag was withdrawn causing the bag to cling in form-fitting fashion around the body of the supercharger. The object here was to reduce the moisture content within the bag by reducing the amount of air in it. While the vacuum cleaner was busy removing the air from the bag, the sealing machine was sealing the open end of the bag. The vacuum cleaner attachment was withdrawn at the very last moment to prevent any air from re-entering the bag.

The sealing machine, operated on a horizontal rail, was propelled by a variable speed electric motor by means of a gear on a gear rack. The sealing itself was done by four ring heated rollers on the machine which sealed the ends under pressure and 170 F temperature.

Upon arrival of the shipment at its destination, the shipping box was carefully disassembled, the sealed strip of the bag, about one inch wide cut off, and the supercharger was removed for attachment to the aircraft engine without further cleaning or removal of rust preventive. Shipping box and bag were returned for re-use if the original shipment had been a domestic destination.

In addition to the shipment of finished units, various detail parts and sub-assemblies were sent to combat supply depots as spare parts. Upon removal of these parts from stores, they were degreased in a vapor type degreaser using a solution which was a composition of trichlorethyline and ethyletrachloride at a temperature of 190 F. On removal from the vapor bath, the parts were permitted to cool to about 130 in the basket in which they had been cleaned. Without being touched by human hand, the parts were next sub-

merged in a rust preventative solution. This compound provided a coating of from 0.005 to 0.015 in. thick. From here on, all parts were handled with rubber gloves. The parts were wrapped in grease-proof paper composed of two 30 lb sheets of grade A grease-proof paper, laminated together with beeswax. The sheets were creped to aid in securing a more perfect sealing of the package. These wrapped parts were then placed in a carton and were directly cushioned by a water repellent package material, and directly over this another layer which had the properties of absorbing rather than repelling moisture. The box was then sealed with standard kraft tape, which was also of a water repellent nature, and the box labeled.

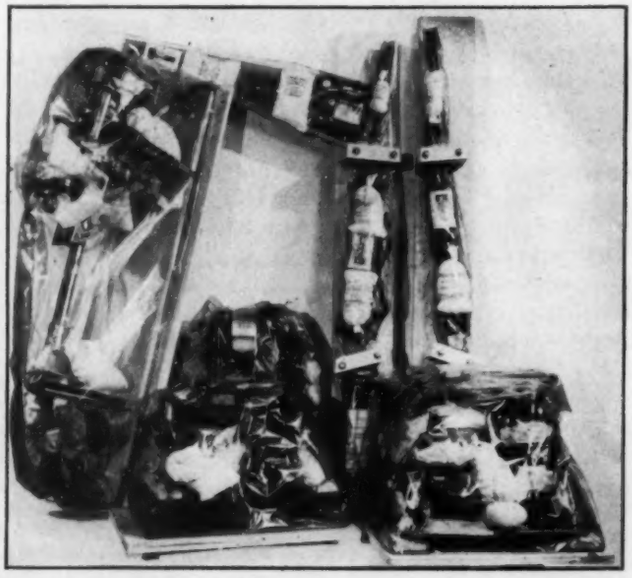
To give additional protection to this packaging, our personnel developed a special process known as "Petrocote." This consisted of a 90 lb plastic-like kraft paper with 30 lb of coating on each side for a total weight of 150 lb. This paper was wrapped around the package and sealed with an electric flat iron which fused the coating both inside and outside and caused it to flow into the seams forming a perfect seal. In addition, the seam was brushed with the coating to doubly safeguard against the entrance of moisture into the package. A label was attached and the package placed in a wooden crate for shipment. This package withstood a four week salt spray test at 110 F, a year on the roof of the plant exposed to all weather conditions, and two weeks of complete submergence in water.

To eliminate corrosion of finished parts in stores, the parts were submerged in one of various approved rust preventives immediately after the final finishing operations and final inspection. On arrival in stores, many of the parts were wrapped in grease-proof paper and the stock so arranged that older parts were withdrawn first.

Since the superchargers, both turbo and gear driven, were aircraft accessories, it is needless to say that close dimensional tolerances and fine finishes free of nicks, burrs, stains, scratches, and other like surface imperfections, were the rule on most parts. Pitting of highly stressed parts or parts revolving at high rates of speed had to be avoided at all costs, and corrosion was undesirable even on parts in the rough machining stages. Rust inhibitors were added to all water bearing coolants, and oil coolants that did not satisfactorily prevent incipient corrosion. Carbon tetrachloride, naptha-base cleaning fluids, gasoline or other high volatility cleaning fluids were replaced in the shop with low viscosity corrosion preventives which served at the same time as cleaning fluids. The conventional cleaning liquids left the surfaces too dry and unprotected.

A secondary problem in connection with corrosion preventives arose when dermatitis assumed alarming proportions among our employees due to exposure of their skins to oils. Needless to say, a secondary preventive to keep both skins and dispositions smooth and calm became the first order of business. That, however, belongs to another field of corrosion prevention.

Figure 2 — These various items of equipment can be kept indefinitely without deterioration, when packaged in this manner.



DISCUSSION

PRESENTED BY

J. C. E. WILLIAMS, Manager Pliofilm Department, Goodyear Tire and Rubber Export Company, Akron, Ohio

L. S. STEINER, Assistant Superintendent of Maintenance, Timken Roller Bearing Company, Steel and Tube Division, Canton, Ohio

J. C. E. Williams: In applying the principles contained in the paper concerning the prevention of rust or corrosion of metal parts due to the presence of moisture, there are certain fundamentals which must be considered. For many years oils, greases and slushing compounds have been used with varying degrees of success, but due to their messy nature and the need for degreasing at point of receipt, plus the fact that factory settings and adjustments were frequently nullified in the process, it was an unsatisfactory and time-consuming method.

An entirely different method of securing safe, practical and economical protection against the ever present problem of rust and corrosion is that just described. This method is known as dehydrated packaging, or, as identified by the armed services, method II.

Now, while it is true that the most extraordinary results have been obtained by this method, its success can be attributed to the easily demonstrable fact that there can be neither rust nor corrosion when the relative humidity of the surrounding air is less than 30 per cent. Method II, then, is simply a means whereby preservation is obtained by maintaining a dry atmosphere surrounding the packaged unit. This is accomplished by enclosing the unit in an essentially moisture and vapor impervious container, and drying the enclosed air.

Once this principle is accepted, the next step is its application. In this connection I would like to comment briefly on the selection of the proper materials and the observing of certain common sense rules in order that best results may be obtained.

First of all let us consider the vapor barrier. Aside from a metal or glass container, an absolutely moisture and vapor-proof barrier is not possible. Therefore in actual practice, diffusion of outside air into the closed volume must be taken into account by selecting a barrier material that will give maximum effectiveness. Likewise the sealing of the barrier material for the final closure is of the utmost importance.

During the course of this development, many materials purporting to be moisture and vapor-proof were tried with the result that rubber hydrochloride was found to be the best all-around material available. It has an extremely low diffusion rate, is easily workable, and it can be sealed by heat so that the moisture-vapor transmission rate of the seal is equal to, or lower than, that of the material itself. It is also transparent permitting visual inspection of the product enclosed so as to determine its condition during any long storage period.

The dehydrating agent has a position of importance equal to that of the barrier material. The dehydrating agent must absorb and retain quantities of water vapor proportional to the relative humidity. In short, the dehydrating agent when placed within the sealed barrier must be able to maintain a relative humidity below that at which rust and corrosion are possible. Similarly the action of the desiccant in absorbing vapors must be purely physical, so that it never becomes deliquescent if saturated. Likewise, it is essential that no corrosive of injurious compounds are given off to attack metals, alloys or other material.

One other important point, it is necessary to emphasize, is that one of the great advantages of dehydrated packaging over other methods of packaging is the fact that the part arrives factory-fresh and ready for immediate use, thorough cleaning before packaging is a basic rule. No corrosion preventive packaging, not even dehydrated packaging, can protect a dirty or contaminated part. The responsibility for thorough cleaning rests directly with the manufacturer, since the item arrives in the same condition that it left the factory.

These comments on method II, or dehydrated packaging, must of necessity be brief. Details concerning the fabrication of the envelope, the amount of dehydrating agent to use, and the equipment available for making the final closure are beyond the scope of this discussion. However, such information is available and will be supplied to those interested. It might be pertinent to add that there are several very capable firms able to design and fabricate the containers, or envelopes, to meet your individual requirements. Insofar as the desiccant is concerned, an empirical formula which has proved satisfactory, was evolved for the calculation of the amount of dehydrating agent necessary to insure an atmosphere less than 30 per cent relative humidity using a rubber hydrochloride moisture vapor barrier having a known maximum moisture-vapor transmission rate.

To sum-up the advantages of dehydrated packaging: your customer will receive your product in factory-fresh clean condition, ready for immediate use; slushing compounds or heavy greases are not necessary, although dual-purpose oils having lubricating and corrosive-preventative qualities can be used to advantage; factory adjustments will not be disturbed; it shows your product to best advantage; and guards your reputation and secures customer's good will.

A brief resume of the development of dehydrated packaging as applied to aircraft engines is interesting. This controlled relative humidity packaging idea is not new, far from it, but it did not assume practical and economical form until a suitable film possessing the necessary characteristics of resistance to moisture-vapor penetration, flexibility, strength, heat-sealability and low cost became available. This film was rubber hydrochloride.

Therefore a properly designed and fabricated envelope together with a physically active, chemically inert, dehydrating agent form the basis of what was later to become a major contribution to our war effort.

Insofar as I know, the first aircraft engine envelope was attempted in 1939. It was not successful, and the idea lay dormant until 1940 when we joined forces in the development with the producer of a well known dehydrating agent and a manufacturer of aircraft engines willing to experiment. From that point on steady progress was made. During the latter part of 1940, we obtained our first noteworthy success when an aircraft engine enclosed in one of our envelopes with dehydrating agent, but without the customary oil, heavy grease and rust preventative compound, and packed in a regular wooden shipping case, was secured to the deck of a freighter for a sea voyage of several months. Inspection after this journey showed little evidence of rust or corrosion. The knowledge gained from this and many other similar experiments led to the development of a suitably designed envelope, determination of the proper amount and distribution of the enclosed dehydrating agent, recommendation concerning a standardized packaging procedure, and the writing of specifications, which enabled practically every aircraft engine produced in this country during the war and since to be preserved in this manner for shipment and storage all over the world. During the critical war years, untold thousands of man-hours were saved and much costly and cumbersome equipment for degreasing engines at destination was rendered unnecessary, inasmuch as the engines arrived ready for immediate installation in aircraft.

This story of the successful development of the envelope for preserving costly and vital aircraft engines, and later for many other critical items, including instruments and spare parts, will enable manufacturers to approach with confidence packaging by this same method today. I refer particularly to manufacturers of such articles as typewriters, sewing machines, outboard motors, electrical motors, instruments, tools, etc. The utmost satisfaction is assured on the part of the manufacturer and his customers, particularly export customers, because articles so packaged are received with precise factory adjustment ready for immediate installation or use. In this connection it will be of interest to note that the army, navy and many aircraft engines manufacturers continue to specify and use dehydrated packaging for shipping and storing aircraft engines.

In closing I want to repeat that if the relative humidity of the contained air in the package is kept below 30 per cent, ordinary rust and corrosion will not occur.

L. S. Steiner: We have used some of this material experimentally and I believe it has possibilities.

Speeding Open Hearth Charging

. . . . new developments in increasing open hearth tonnage through improvements in furnace practice may show that the limiting factors will be material handling and scrap charging . . . .

By R J. HARRY
Vice President
Alliance Machine Company
Alliance, Ohio

▲ IN recent years, and especially during the war, when the demands for increased steel production were so imperative, much study was given to a great variety of methods for accelerating the production of steel in the open hearth.

The extensive use of oxygen in the last year, and particularly in the last six months, has resulted in tremendous reductions in the time required to produce a heat of steel. Some shops are able to reduce the melting time for a heat approximately 50 per cent by the supplementary use of oxygen. On the old basis of melting steel, assuming a 200 ton heat, and total time for producing a heat of steel is twelve hours with a charging time of two hours, then the charging time is 16⅔ per cent of the time to produce a heat of steel.

With the supplementary use of oxygen and assuming a 200 ton heat of steel can be produced in six hours with a charging time of two hours, the charging time under these conditions becomes 33⅓ per cent of the time to produce a heat of steel. It is therefore, only logical that operating open hearth men should be seeking ways and means for reducing the charging time to a minimum.

Many schemes have been advanced to accomplish rapid charging. Some of these schemes require special roof construction, and an overlapping continuous door arrangement which makes it possible to open the entire front of the furnace, sectionally, or totally as required.

Many electric furnaces are designed with removable roofs, and with the use of special drop bottom charging boxes the furnaces can be charged at the top, using a standard electric overhead traveling crane.

Various types of continuous charging equipment have been proposed, but in spite of the advantages claimed for the many schemes that have been developed, the facts are, that charging of the open hearth is accomplished almost exclusively by the standard open hearth charging machine. These in-and-out charging machines are equipped with an angular elevating, revolving peel. The peel is equipped with a lock rod which prevents the charging box from disengaging as it is revolved in the furnace to deposit the burden in the open hearth.

When charging machines were first developed to replace hard charging, a little over a half a century ago, the average size of the open hearth furnace was about 25 tons capacity. Naturally, the size of the charging machine and the charging machine boxes were relatively small and the size of the open hearth doors were likewise small to accommodate the small boxes. As the size of the open hearth furnace was increased, little attention was paid to the size of the open hearth charging machine and the boxes. This was probably due to the fact that mechanical charging was far superior to

Presented before AISE Pittsburgh District Section Meeting, April 14, 1947

TABLE I

Lifting Magnet Capacities in Pounds

Class of material	Magnet sizes							
	18 in.	24 in.	29 in.	39 in.	45 in.	55 in.	65 in.	65 in. deep
Skull cracker balls with standard magnets	2,100	4,000	8,000	12,000	16,000	20,000	30,000	38,000
Skull cracker balls with special pole shoe	3,000	6,000	10,500	18,000	24,000	30,000	40,000	45,000
Slabs	3,300	6,500	13,000	20,000	38,000	50,000	65,000	70,000
Machine cast pig from stock pile	150	275	550	900	1,580	2,500	3,500	4,400
Sand cast pig from stock pile	130	250	430	800	1,420	2,300	3,000	4,000
Machine cast pig from railroad cars	130	250	430	800	1,420	2,300	3,000	4,000
Sand cast pig from railroad cars	120	225	390	700	1,380	2,200	2,850	3,800
Heavy melting scrap	150	275	550	900	1,580	2,500	3,500	4,400
Plate scrap	130	250	500	700	1,100	1,500	2,300	2,800
Broken scrap	110	200	350	600	1,000	1,400	1,800	2,300
Cast iron bearings	110	200	350	600	1,100	1,550	2,400	2,900
Steel turnings	50	100	175	300	450	750	1,200	1,700

the hand charging that had prevailed up to that time.

Until recent years, charging machines handled mostly heavy scrap consisting of scrap rails, pig iron, plate scrap, bloom ends, structural shapes, etc., and as a consequence the charging time was not great even though the charging boxes were small.

With the increased production of automobile strip, sheet metal shearings and stampings, much of the scrap now handled in the charging process is light and bulky, and requires a great number of boxes of scrap to charge a furnace. In talking with several open hearth operating men, I find that it is not exceptional to charge 160 boxes of scrap for a 190 ton heat where a 40 per cent charge of hot metal is used, and limestone requirements of 6 to 10 per cent of the metallic charge.

Since it takes the same length of time to charge a light box of scrap as it does to charge a box containing a heavy load, it seems logical that every effort should be made to increase the density of the scrap so that the least number of boxes of scrap would be required for each heat. This calls for scrap preparation in the stock yard. Since scrap yard labor is generally cheaper than furnace labor any scrap preparation which would result in reducing the charging time should result in reducing ingot costs.

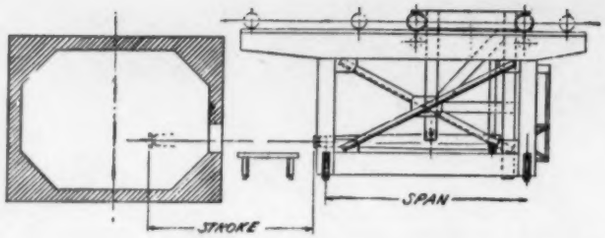
Another reason for the bundling or briquetting of light scrap is, that in the charging process the loose light scrap is so deep in the furnace that much time is lost in pushing back and leveling off the scrap. In this process, the roof of the furnace is often injured. Holes are sometimes punched in the roof when a box is being revolved to empty the charge and the light loose scrap is too deep in the furnace, thus allowing insufficient space between the roof and the top of charge. Bailing and briquetting would also make it unnecessary to take extra hours to melt down loose scrap to provide room in the furnace body to charge the balance of the scrap required for a heat.

In the early days of the open hearth, when furnaces were of 25 to 40 tons capacity, charging machines were usually of 3 to 5 tons capacity. On account of the restricted space in front of the furnaces, in the early open hearth designs, most of the charging machines were of the high floor type. With this type of machine, the trolley operates on girders located about 8 to 10 feet above the general floor level. The operator is located in a cab suspended from the trolley which enables him to operate the lock rod and provides the maximum visibility of the box and charge in the furnace. In the earlier design of this type of charging machine, the operator was raised and lowered when the peel was tilted. On the later type of machines the operator has a fixed elevation under all conditions of charging, but moves with the trolley travel. This design permits the girders to project over the ingot buggy tracks in front of the furnace and provides the maximum travel of the trolley and peel for a given bridge span.

The high floor type charging machine is inherently less rugged than the low floor type charging machine which is installed in all modern open hearths. In many of the old, and some of the newer open hearths where sufficient space is not available to install the low type charging machine, the high floor type machine is the only solution to mechanical charging.

TABLE II

Size of scrap box in cu ft	Capacity of scrap box in pounds for various types of scrap								
	Short, heavy crop ends	Billet ends	Foundry gates and risers	Rails	Heavy railroad scrap	Crushed turnings	Compressed bundles	Light railroad scrap	Automobile scrap
20	4,900	3,700	2,700	2,640	1,750	1,120	1,000	900	840
25	6,125	4,625	3,375	3,300	2,190	1,400	1,250	1,125	1,050
30	7,350	5,550	4,050	3,960	2,625	1,680	1,500	1,350	1,260
40	9,800	7,400	5,400	5,280	3,500	2,240	2,000	1,800	1,680
50	12,250	9,250	6,750	6,600	4,375	2,800	2,500	2,250	2,100
60	14,700	11,100	8,100	7,900	5,250	3,360	3,000	2,700	2,520



CAPACITY IN TONS	SPAN C TO C OF RAILS	STROKE OF RAM	TOTAL WT OF CHARGER	DRAW BAR PULL BASED ON 20% FRICTION	MAX. WHEEL LOAD WITH FULLY LOADED BOX IN EXTREME POSITION IN FURNACE (4 WHEELS ON BRIDGE)
1	11'-0"	12'-0"	50,000	10,000	25,000
2	12'-0"	14'-0"	65,000	13,000	33,000
3	13'-0"	16'-0"	85,000	17,000	43,000
5	14'-6"	17'-0"	115,000	23,000	59,000
7½	14'-6"	17'-0"	130,000	26,000	69,000
10	15'-0"	17'-6"	140,000	28,700	74,000

Figure 1 — The high floor type charging machine is used where sufficient space is not available to install the low type charging machine. Bridge span and stroke can be modified to suit space available.

Owing to the relatively short span, short stroke, short peel and generally compact design, the total weight and maximum wheel load of the high type charger is less than for the corresponding capacity low type charger, and as a consequence the supporting floor structure does not need to be so heavy.

The present low type charging machine is inherently the most rugged type that can be built, and its construction lends itself to substantial lateral bracing. This is very essential when you consider that one of the main duties of a modern open hearth charging machine is to move a train of loaded charging box buggies in order to spot the box to be charged in front of the open hearth door. Many engineers in ordering charging machines require a guaranteed draw bar pull the same as for locomotives.

A modern 12-15 ton open hearth charging machine weighs in excess of 200,000 pounds. It is, therefore, possible to obtain a draw bar pull in excess of 40,000 pounds before slipping of the wheels occurs on the basis of a coefficient of friction of 20 per cent between the wheels and rail. When you consider that many of the locomotives used in open hearths to handle charging box buggies weigh less than 50 tons, it is not hard to realize that when the locomotive stalls, the charging machine can handle the train without difficulty.

Accelerating and decelerating trains of loaded scrap boxes impose the maximum stresses on the pool and bridge structure, and are the chief reasons for heavy gusset plates, outrigger girders and heavy lateral bracing.

In most modern open hearths, the charging machines have a span of approximately 25 ft-0 in., and a stroke of about 20 ft-0 in. In order to speed up the charging process, steel mill engineers have been specifying charging machines of larger capacities, and charging machines ranging in capacity from 10 to 15 tons are standard in most modern high production shops.

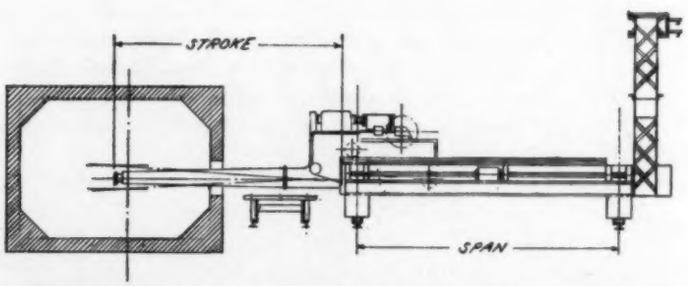
In cases where larger capacity and faster operating machines are required to speed up the charging process, and sufficient floor space is available, it is absolutely essential to check the strength of the supporting structure. In many cases, the supporting structure has been found to be inadequate, and the reinforcing of this structure is one of the major items of expense in connection with such a change. The rails and the floor beams should also be checked for the additional load.

In a recent installation where we replaced a small capacity charging machine with one of a larger capacity, it was found that the supporting structure was sufficiently strong but the rails and floor beams were inadequate for the increased load. It became necessary, therefore, to construct this charging machine with compensating trucks and eight track wheels on the bridge. While the total load on the structure was not decreased by the eight wheel construction, the individual wheel loads were reduced to one-half the value obtainable with the four wheel bridge construction. The use of the eight wheel bridge construction in this case made it unnecessary to make any changes in the floor construction or size of rail. The use of eight wheels reduced the draw bar pull 50 per cent, but the charging machine was still able to move the maximum number of charging buggies without difficulty.

In order to utilize the advantages of the faster and larger capacity charging machines, it is absolutely essential to bundle the light scrap in the stock yard before it is placed in the charging box. Some of the steel mills are installing modern equipment to bundle light scrap economically.

The speeding up of the charging process must start in the stock yard where the scrap classification, bundling and briquetting is accomplished. Since greatly increased tonnages will be produced in the present open hearth plants with the aid of newly designed burners and the use of oxygen, both in melting the scrap, and also in the elimination of carbon by the use of the oxygen lance in the bath, the stock yard must be prepared to handle greatly increased tonnages of scrap. This will, in many cases, require larger stock yards to handle the

Figure 2 — This tabulation gives average figures for low floor type charging machines installations. Bridge span and stroke can be modified to suit space available.



CAPACITY IN TONS	SPAN C TO C OF RAILS	STROKE OF RAM	TOTAL WT. OF CHARGER	DRAW BAR PULL BASED ON 20% FRICTION	MAX. WHEEL LOAD WITH FULLY LOADED BOX IN EXTREME POSITION IN FURNACE (4 WHEELS ON BRIDGE)
3	22'-0"	18'-0"	125,000	25,000	60,000
5	24'-0"	20'-0"	150,000	30,000	72,000
7½	25'-0"	20'-0"	175,000	35,000	86,000
10	26'-0"	20'-0"	200,000	40,000	100,000
12	27'-0"	21'-0"	220,000	44,000	110,000
15	27'-0"	21'-0"	240,000	48,000	120,000

increased capacity. In many cases the size of the stock yard is the limiting factor in the production of the open hearth. This condition must be remedied before full advantage can be taken of the reduced melting time in the furnace. Scrap lifting magnets of approximately 80 inches diameter are now being built which, with the use of high speed stock cranes, should greatly reduce the time required to unload a car of scrap and increase the capacity of the present stock yards.

Larger charging boxes and larger furnace doors are also a necessity if full advantage is to be taken of the larger capacity charging machines. Most of the newer charging machines can handle a load of 12 to 15 tons at the end of the peel. If you allow two tons for the weight of the box, the net load could be 10 to 13 tons. If furnace doors and charging boxes were designed for the larger loads, it is not hard to visualize how quickly a furnace could be charged with a modern charging machine capable of charging boxes at the rate of two per minute.

If scrap boxes to hold an average load of 4 tons of prepared scrap were available, only 30 boxes would be required for a heat as against 160 boxes which are sometimes now required, and the savings in charging time should be proportional to the number of boxes handled. The reduction in the number of boxes handled will greatly reduce the wear and tear on the charging machine, and result in lower maintenance costs. It would also make it possible to produce the same tonnage with less charging machines or greater tonnage with the same number of charging machines. Fewer scrap boxes and buggies would be required to handle the increased production.

Changing the size of scrap boxes always presents a mean operating condition during the transition period. When larger boxes are designed, consideration must be given to the strength of the end of the peel where it engages the slot in the end of the scrap box, and to the size of the lock rod. In many cases, the size of the scrap box has been increased and the end of the peel not changed to take care of the additional load. This has resulted in many peel failures and lost production time. Many plants are now using a long forged steel peel with a short cast steel end which engages the scrap box. Since this is the part of the peel that goes into the furnace and is most subject to breakage, the replacements are less costly. Much of the benefits derived from larger boxes will be lost if the density of the scrap is not increased by bailing or briquetting. In many cases, more economies will be effected if scrap is bailed and the present boxes used than to change to larger sized boxes and fill them with loose scrap. It must be kept in mind that it is not so much the size of the box, but rather the weight of the contents of the box that determines the number of boxes per heat. Naturally, the best charging time can be made by using large boxes and dense scrap. Boxes of 50 cubic feet capacity are being used in several open hearths now. The size of boxes should not be increased until a thorough check is made in the open hearth to determine if the operating conditions will permit the use of larger boxes. Many plants have found it necessary to make changes in the furnace construction and charging machines in order to successfully use larger boxes.

Many of the new electric furnace plants are equipped with standard low type charging machines for the regular charging work, and a revolving trolley crane type charging machine for adding fluxes and alloys. The loaded boxes of fluxes and alloys are usually stored on the floor or in the lean-to. The revolving trolley feature, and the fact that the peel can be lowered in the horizontal position to the floor level, makes this machine indispensable for miscellaneous work in the open hearth. These crane type charging machines are equipped with an auxiliary trolley with sufficient capacity to remove the roof of the electric furnace it serves and to install the new roof. When roofs are changed, large pieces of scrap, too large to be charged through the doors are charged into the top of the furnace by means of the auxiliary trolley. We have recently built two ten-ton machines of this type for modern electric furnace plants and the operation has been most successful.

Many of the older open hearth plants are plagued with a narrow gage track system for scrap box buggies. This will, in many cases, limit the size of the scrap box and will prevent the use of the larger and more powerful scrap lifting magnets on account of spillage when loading the short scrap boxes in the stock yard.

Recommendations for speeding up the charging process can be summarized as follows:

1. High speed stock cranes with large diameter high lifting capacity magnets for speedy unloading of cars.
2. Adequate size of stock yard to handle the increased open hearth production.
3. Facilities for increasing the density of light scrap and adequate burning equipment, thereby reducing the number of boxes required per heat.
4. Larger scrap boxes to handle loads and further reduce the number of boxes required per heat.
5. Larger doors in the open hearth furnaces to accommodate the larger boxes.
6. Charging machines of sufficient speed and capacity to handle the larger boxes.

DISCUSSION

PRESENTED BY

HARVEY W. BALL, Assistant Chief Engineer, Morgan Engineering Company, Alliance, Ohio

R. J. HARRY, Vice President, Alliance Machine Company, Alliance, Ohio

F. H. DYKE, Assistant Chief Engineer, Wheeling Steel Corporation, Steubenville, Ohio

R. L. SCHELL, Superintendent, Open Hearth, Edgewater Steel Company, Oakmont, Pennsylvania

A. G. ERICSON, Chief Engineer, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania

H. R. COULSON, Superintendent, Open Hearth, Bethlehem Steel Company, Johnstown, Pennsylvania

L. A. LAMBING, Superintendent, Open Hearth and Bessemer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

Harvey W. Ball: The author said the high type charger cannot be made as husky as the low type. I

take exception to that, we shipped two high type chargers that I believe was quite a surprise to the purchasers, because when they looked at it I do not believe they thought it would go in the open hearth. They replaced two that had been in operation about 40 years. If the author saw these machines he would agree that they can be built as husky as the low type.

R. J. Harry: I do not say that the high floor type charging machines cannot be built husky, but I do contend that inherently this type of machine is not as rugged as the low floor type charging machine. With the high floor type charging machine the trolley operates on girders approximately 8 to 10 ft above the floor level, and on this trolley is a pintle bracket which supports the charging machine peel with its revolving mechanism. This construction results in a machine which is inherently less rigid than a low floor type charging machine whose peel and trolley structure are on the same elevation. The fact that practically all new open hearths are equipped with low floor type charging machines supports this contention.

F. H. Dyke: Almost everyone, in these days of light scrap, has given some thought to making charging boxes larger; in fact, as was brought out, double the size. There are some plants where they are handicapped by the front rail of the charging machine being so close to the furnace that the box cannot be lengthened. Is there any way that the design of the front of the charging machine could be cut back so that a longer box would be possible? An extra space between the machine and furnace buckstays would help out materially in some cases.

R. J. Harry: In many cases there is sufficient room between the end of the charging machine and the buckstays of the furnace to install longer boxes, and in many cases the end of the charging machine girders can be shortened to provide more room. Generally, however, this will result in reducing the stroke and travel of the trolley.

One thing in our favor is the fact that, when you change charging box sizes, you are dealing in three dimensions, namely, width, length and depth, and a small increase in all three dimensions results in a great increase in the capacity of the charging box. If, for example, you have a charging box approximately 2 ft wide × 2 ft deep and 5 ft long inside, a capacity of 20 cu ft, as would be used in connection with a narrow gage track system, if the depth would be increased 6 in., the width 6 in., and the length 1 ft, you would have a charging box with a capacity of 37½ cu ft, which is almost twice the capacity of the old box. This fact may enable many of the open hearth operators to change the size of the boxes without having to alter the furnace design or size of the doors. It is, of course understood that the charging machine must have the necessary capacity to handle the larger size boxes.

Many of the open hearth operators tap large heats from their furnaces by banking up the doors, and this procedure naturally reduces the space for the charging machine operator to get the charging box into the furnace. The banking of the doors is frequently the main reason for preventing increase in the charging box size.

I feel that a study of the size of charging boxes will show that in many cases these boxes can be greatly increased in capacity without changing the furnace construction in any way.

R. L. Schell: The question of wider charging boxes has been mentioned. The comment on this matter I wish to make is, that in order to widen the boxes, the buckstays must be made narrower. When boxes are widened it introduces other problems such as inability to turn, or dump the box with present equipment; as well as greater danger of hitting the furnace roof when the box is dumped and scrap is piled high in the furnace.

We have a box of the following inside dimensions: length 84 in., width 30 in., depth 18 in. The opening in our charging door is 40 in. in width by about 50 in. in height. With the light scrap we are now forced to buy, with the consequent overhang, there is not a great deal of clearance between the scrap and door jambs. We buy as much bundled scrap as we can, but under present conditions find it almost impossible to purchase this type of scrap.

A. G. Ericson: We recognize that with the speeding up of the open hearth heat, we have to cut down the charging time, and that can be done by larger boxes. In one of the shops at Homestead, the boxes are about 44 cubic feet at present, and yet I am sure we would benefit by having even larger boxes. However, how far we can go in that direction is hard to say.

H. R. Coulson: I will say we have very small clearances between our boxes and columns, and our engineering department has studied it time and time again and conclude that we cannot get any longer boxes in. We have made a few of them wider, we have increased the capacity per box, but we have not changed our charging machine. Our charging machine operators thus have a little difficulty in turning the boxes, because they have to be very careful or they will hit the roof of the furnace. So far to date we have not gained much by charging three boxes instead of four per car, because the man has to be so much more careful, in order not to hit the side of the door jamb, and when he gets in the furnace if he is not very careful in turning it over, he hits the roof. So maybe the comments of Mr. Ericson are correct, larger boxes will speed up charging, but I think so far to date you will not find a whole lot of improvement.

L. A. Lambing: The author seems to understand a lot of the difficulties the open hearth operator is faced with every day. There is one thing about increasing the size of charging boxes; you have to increase them only about 50 per cent to get 100 per cent increase in the load. Another thing, in the width of the charging boxes, you cannot go too wide for after you get some scrap in the furnace you cannot turn the boxes over. You can go up a little in height and still turn them over and you can change the size of doors. We have taken one door off of a six-door furnace and changed to five doors 56 in. wide. We now charge large ingot butts without much trouble. There are a lot of difficulties in going to larger boxes and larger charging machines.

Rust Preventive Compounds

. . . . the use of rust preventive compounds to eliminate corrosion is usually much more economical than later removal of the rust which might occur when no precautions are taken . . . .

By HOWARD B. CARPENTER
Standard Oil Company of New Jersey
New York, New York

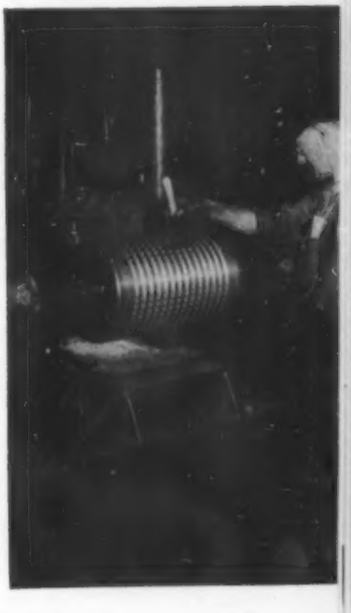


Figure 1 — The operator is brush-coating freshly machined finishing rolls for rust protection during assembly and storage.

▲ THE past few years have witnessed considerable change in the attitude of industry toward rust. Formerly it was accepted as a necessary evil due as much as anything to the fact that the available rust preventive compounds were none too reliable. When the laboratory replaced the kitchen stove, industry realized that one of the greatest sources of economic waste can be minimized by the use of scientifically developed rust preventive compounds. Then the need is greater, for manufacturing has become more and more decentralized and the protection of parts in process has taken on increased importance. This is also true of assembled units during shipment and storage prior to installation in a complete system, for example, the pump for a hydraulic system.

For many years paint and resistant metals such as tin, lead, and zinc were the principal rust preventives, but due to the difficulty of removal it was not practical to use them on finished surfaces, especially those subject to sliding contact, where rust produces heavy financial losses. Until a few years ago, the protection given to such surfaces usually consisted of a so-called "slushing compound" made up of petrolatum and oil. The protection, however, was not reliable since uninhibited oil, petrolatum or grease cannot be depended upon to prevent rust. Now many proven rust preventive compounds are available and their value has been demonstrated in very extensive use by the armed forces during the war years.

The principal function of rust preventive compounds is to act as a moisture barrier. Some of them also afford protection against the action of chemically corrosive gases, but it should be borne in mind that this is usually a physical and not a chemical action.

Rust preventive compounds are *not* rust removers. They are effective only when applied to surfaces which are *thoroughly* clean and dry. This cannot be overemphasized as the best rust preventives are practically worthless if applied to a dirty or moist surface. Rust itself is spongy in nature and if not removed is apt to retain moisture, thereby promoting corrosion under the film.

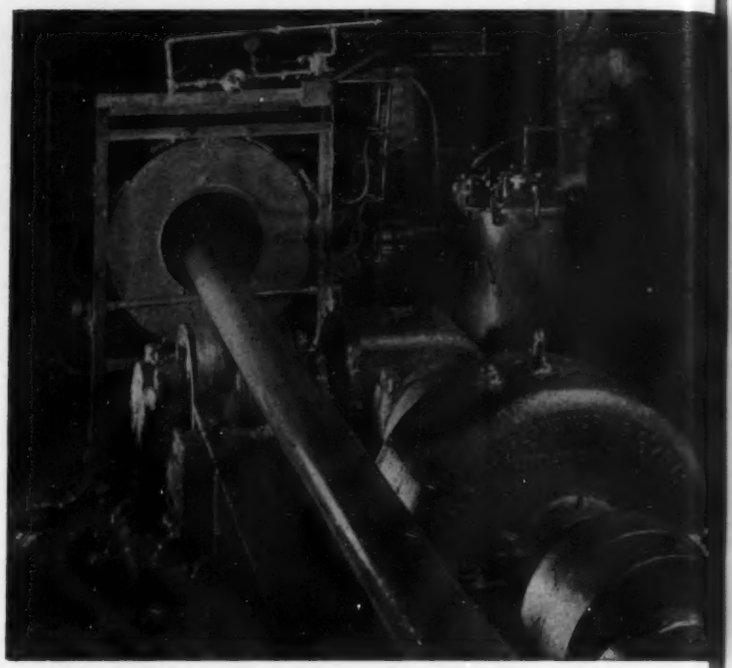
Modern rust preventive compounds may be described as follows, but the comments should be considered as being of a general nature, as doubtless among many manufacturers there are exceptions. These compounds fall into two general categories which in turn may be subdivided. The predominant classification is the non-hard-drying, removable group. In general, these products have a petroleum base and are characterized by their ease of removal with petroleum solvents without adverse effect on the metal surface to which they have been applied. Due to their petroleum nature, many of these products will serve as lubricants, if for any reason they are not removed before operation. This non-hard-drying group can be subdivided as follows:

1. *Plastic type* — These are grease-like materials and

Presented before AISE Annual Convention, Cleveland, Ohio, October 3, 1946

Figure 2 (Left) — A garden sprayer can be used to apply some types of rust prevention compounds.

Figure 3 (Below) — A hard-drying transparent product is ideal for automatic spray coating of new pipe.



the heaviest grade usually consists of petrolatum plus rust inhibitors. Other grades of softer consistency and somewhat lower melting point are obtained by adding an oil of fairly high viscosity to the petrolatum base. As the consistency of products of this type decreases, their ease of application and removal increases as well as the coverage per gallon, although the anticipated protection decreases. They are characterized by reasonable resistance to abrasion, a fair amount of self-healing power in the case of film rupture, and the ability to expand and contract with the metal. They are also resistant to displacement which tends to result from contact under pressure with the interior surface of a shipping container. Under conditions involving direct exposure to the elements, the heaviest grade affords the best protection of any in the removable category. Its outer surface slowly hardens on exposure to the atmosphere, while underneath the film retains its original consistency and self-heating properties. The plastic type should be used wherever possible except where solvent type products will give adequate protection, such as in certain phases of indoor storage.

2. *Fluid type* — These consist of petroleum oils of various viscosities to which rust inhibitors have been added. As a general rule they are used where the application of the plastic type would be difficult or unsuitable, such as oil-lubricated bearings, hydraulic systems, turbines, gear cases, etc. The tendency for this type to drain or to be removed by wick action results in less permanent protection than that afforded by the plastic type

3. *Internal combustion engine type* — This is a modification of the fluid type which includes a neutralizer for the acidic products of combustion, plus other additives which make the product suitable for use as a motor oil. This insures against damage in case replacement is neglected when the engine is recommissioned.

4. *Thin film type* — Products of this type contain a high percentage of a petroleum solvent which evaporates leaving a reasonably hard, non-transparent, thin film. They are generally considered suitable for either outdoor or indoor service as alternates to the plastic type.

5. *Solvent type* — In general, these products consist of solutions of rust inhibitors in mineral spirits which, upon evaporation, leaves a thin, transparent, but effective rust preventive film. This film does not dry hard but remains somewhat flexible and tacky over long periods. Solvent type products are not suitable for use outdoors but give excellent indoor protection, particularly on material or parts in process, without interfering with visual inspection or the reading of identifying marks. In one special modification of the solvent type, water displacing and fingerprint neutralizing characteristics are added. When applied to a wet surface, the water is immediately and completely displaced, fingerprint residues are neutralized, and the surface left coated with an effective rust preventive film.

The other general category is the hard-drying group. These are usually of the so-called lacquer type and provide a film which is hard enough to resist the abrasion encountered in shipping, and yet sufficiently flexible to withstand the tendency of the expansion and contraction of the metal to cause cracking. Being transparent they do not hide defects or markings for identification. The protective film can be machined off, left to wear off, or painted over with pigmented products. The conventional products dry to touch in four to six hours and dry hard in twenty-four hours. Faster drying grades are also available.

One specialty in the hard-drying group is an aluminum paint with a special vehicle which is highly resistant to the particularly severe action of hot oil, hot water, or a combination of the two. This type of coating has a very satisfactory record for the protection of

the interiors of the lubrication systems and sumps, hydraulic gear cases, and other surfaces subject to the same type of corrosive action.

Another type of rust inhibited oil should be mentioned to prevent further acceptance of a misunderstanding. Many prime grade turbine oils contain what is called a rust inhibitor. This is not a misnomer but refers only to protection from rust resulting from the presence of water with which a lubricant has become contaminated. So far as we know such inhibitors furnish no protection against humid or corrosive atmospheres.

The development of effective rust preventives has necessitated the development of laboratory methods for the evaluation of performance. Considerable progress has been made but further improvement is desirable as well as a means of predicting service life from laboratory results. The most commonly used performance test is known as the humidity cabinet where mild steel panels, usually 2 × 3 in. or 2 × 4 in. and 1/16 or 1/8 in. thick, after being sandblasted or polished, are coated with the material under test and exposed to a temperature of 100 or 120 F and a relative humidity closely approaching 100 per cent. The rust preventives are rated by the number of hours which elapse before rusting occurs. This test indicates the relative protection to be expected from exposure to atmospheric humidity.

In the salt spray test, similar panels are exposed to an atmosphere of atomized sodium chloride solution. The results give a fair idea of the relative protection to be expected from exposure to salt-laden atmospheres such as those encountered in ocean shipment. Another test involving immersion in synthetic sea water gives similar indications.

A water spray test and exposure in a weatherometer indicate relative resistance to removal by the action of the elements as well as resistance to their corrosive action.

The results from these tests are not as reproducible as might be desired, but they are very informative providing it is borne in mind that they indicate simply an order of magnitude. For example, a product which furnished protection for 225 hours in a humidity cabinet should not be classed as superior to one which ran 200 hours. One which protected for 200 hours should be considered better than one which gave 100 hours but there is no reason to feel that it would give twice the protective life in actual service.

The hard-drying types of rust preventives are usually tested by exposing panels to the weather at an angle of 45 degrees, facing south, much in the same manner as is used for pigmented coatings.

Now we come to the methods of application. As previously mentioned, rust preventives should be applied only to surfaces which are thoroughly clean and dry with the single exception of the application to wet surfaces of a solvent type product with water displacing properties.

There is no universal method of cleaning which will properly condition all surfaces for the application of protective coatings. Where rusting has already occurred, the use of steel wool, wire brushing or even sand or shot-blasting is effective. A hot alkali bath followed by a thorough rinse is also suitable. Chlorinated solvents have given a good account of themselves although care must be taken to make certain that there is no chlorine liberated in a way which permits a union with water to form corrosive hydrochloric acid. Where the contamination consists of dirt held in place by oil or grease, the use of petroleum solvents is probably the most efficient method. Mineral spirits, also called Stoddard solvent or dry cleaners' fluid, is the most generally used petroleum product. It has the advantage of a higher evaporation rate than kerosene, without increasing the fire hazard, according to the classification of the Underwriters' Laboratories, Inc. The use of kerosene should

Figure 4 (Above — A bituminous coating is being used to protect the roll neck bearings.

Figure 5 (Right) — The caustic bath at the right is used to remove cutting oil before the pipe sections and nipples shown are dipped in a fluid type rust preventative.

Figure 6 — A non-drying coating is being applied by hand on steel mill rolls.

be avoided because of its tendency to promote corrosion. Care should be taken to keep a petroleum solvent from contact with rubber or other materials which would be affected. The use of a clean solvent is essential and it must be replenished whenever it becomes sufficiently contaminated to prevent fulfillment of its purpose.

Fingerprints, as most of us realize, actively promote corrosion. The best protection is obtained by the use of canvas or synthetic rubber gloves. However, this is not always practical and, although the use of bare hands does not necessarily deposit fingerprints, the chances are sufficiently great to warrant preventive measures. So far as we know these deposits are not removed by mineral spirits or other commercially used cleaning agents. Conventional rust preventives are also ineffective but solvent type products to which fingerprint neutralizing agents have been added have proven very effective over a considerable period of time. The efficacy of some is improved by the addition of 5 to 10 per cent water. Special products of the solvent type having water displacing and fingerprint neutralizing characteristics in addition to their rust preventive property have found wide acceptance in industry.

The removal of moisture or a soluble oil emulsion from a surface before the application of a rust preventive is often not as simple as it might appear. The use of compressed air or cloths is apt to cause contamination. The former may not be dry, clean or oil free, whereas cloths are hard to keep clean and dry and may leave lint on the dried surface. Here again, the advantages of a solvent type rust preventive with water displacing qualities are apparent.

Although the supplier of a rust preventive compound is the one best qualified to specify the proper procedure for application, the following general comments may be helpful. Application should be made as promptly as possible after cleaning, and in such a manner as to give a uniform and continuous coating to the surfaces to be protected. Dipping is preferred wherever possible as it insures complete coverage, although spraying is also effective. Application may also be made by brush, swab, or roller.

In the case of the plastic type, the piece being dipped should be immersed long enough to bring its surface temperature up near the melting point of the compound. Otherwise a poor bond may be expected. This is also true when this type is applied by brush or swab. Too rapid chilling of the compound prevents a good bond. Generally speaking the plastic type compounds cannot be sprayed, although equipment is available which will apply the softer grades by this method. As an alternate to heating, plastic type products may be cut back with mineral spirits which evaporates after application. Heating is preferred, however, as affording somewhat better protection and not requiring the time for the evaporation of the solvent.

It is often unnecessary to disassemble machinery such as turbines, gear cases, cylinders, etc., for the application of a rust preventive oil to the interior surfaces.

Figure 7 — Sheet stock requires care in handling to prevent discoloration from fingerprints.

Figure 8 — Steel dies should be protected by a rust preventive while in storage.

Fogging by high pressure spray through openings can be quite effective, although this method must be used with discretion, if complete coverage is to be obtained.

Whenever possible liquid type rust preventives should be drained, filtered and reused with the exception of the internal combustion engine type, in which service the acid neutralizer is consumed. Re-use must, therefore, be confined to applications which do not require this characteristic. The manufacturer of the rust preventive compound is the one best qualified to recommend suitable types of filter media. For many products, however, the rust inhibitors are in true solution and will pass unchanged through most of the chemically inert filtering media. When liquid rust preventives are drained, the film remaining on the coated surfaces will provide full protection, although it is often wise to attach a prominent tag calling attention to the need of refilling with the normal lubricant before operation.

The thin film or solvent type products may be applied by dip, spray or brush.

Care must be taken, especially in the case of petroleum base rust preventives, not to apply them to nonmetallic parts such as those fabricated of rubber, cork, paper, leather, fabric or plastics. Where contact cannot be avoided by shielding or other means, the heaviest of the plastic type compounds should be used. This very viscous type will have the least and probably an unappreciable effect as it contains but little oil.

Your attention is also called to the fact that precaution must be taken when application is made by spray. All petroleum products when atomized represent a health hazard if taken into the lungs in any appreciable quantity. It is, therefore, recommended that adequate local ventilation be provided when a petroleum base product is applied by spray. Proper precautions, as established by the National Board of Fire Underwriters, must also be taken in connection with any possible fire hazard.

When preserving internal combustion engines they should first be allowed to cool to ambient temperature. The crankcase is then drained, flushed, and refilled with the rust preventive oil using the minimum quantity necessary for safe operation of the engine. After this the engine is operated for a short period at idling speed and no load. The rust preventive is then injected into the cylinders above the pistons by pouring it slowly into the carburetor air intake in the case of spark ignition engines, or by using it as fuel during the last few minutes in the case of diesels. After the engine stops and has cooled, the spark plugs or fuel injectors should be removed and the preservative fogged into each cylinder with the piston down in each case if possible. Before replacing the plugs or injectors, the engine should be turned over a few revolutions to obtain complete distribution.

As has already been intimated, the non-hard-drying rust preventive compounds may be removed with petroleum solvents. Mineral spirits is preferred although kerosene or white gasoline are also suitable. Rags or waste soaked in hot water may be used but this method is apt to be more laborious. Many of the rust preventive compounds are lubricants and need not be removed from bearings, gears, etc., although all sumps, reservoirs and crankcases should be drained and refilled with the lubricant recommended for regular service.

As a rule no attempt is made to remove the hard-drying compounds, but should this become necessary, the use of a standard grade of paint remover is recommended.

Getting down to specific steel mill applications there seem to be three categories in which the use of rust preventive compounds can very profitably be considered. The first is machinery or equipment kept in stand-by storage without disassembly. Any attempt to prescribe for this classification in detail would be impractical but we believe the proper type or types of products and methods of application can be determined from the general descriptions previously given in this paper.

The second group includes tools and spare parts in storage such as rolls, saws, mandrels, gears, armatures, heavy machine parts, housing screws, steel dies, etc. Some specific examples may be of help. For example, the necks only of mill rolls should be coated with the

Figure 9 — Ball bearings are protected from rust by dipping a wire basket containing them into a heated plaster compound.

heaviest grade of plastic type product. The roll neck itself and the coating material should both be at sufficiently high temperatures to prevent too rapid chilling at the surface of the metal with the resulting poor bond. If applied by brush or swab, the motion should be circumferential rather than longitudinal, thus providing a more permanent bond. If the neck is wet as it comes off the mill, a preliminary coating of the water displacing type should be applied. The same procedure should be followed for work rolls and backing rolls from sheet and strip mills, but in addition the same treatment including the water displacing product should be given the roll surface itself immediately as it comes from the grinder after refinishing. After a period of service the corrosive action of the cooling water often makes it difficult to remove the inner race of an anti-friction bearing which has been press fitted to a roll neck. This condition can be alleviated by coating the neck with a solvent type preservative with water displacing properties before pressing the race in place.

Spare rolls and line shaft sections of roller conveyors should have their gears and anti-friction bearings coated with the lightest consistency grade of the plastic type products, although at times it is desirable to use a fluid product of high viscosity in order to obtain complete coverage.

The third category covers finished products. For sheets, strip steel, bar stock, etc., protected from the weather, a solvent type product should be used. Preservatives of this class have also given very satisfactory service on continuous strip mills and on steel wire between drawing and stranding in rope manufacture. For products shipped exposed to the elements, the use of hard-drying rust preventive compounds should be seriously considered. This type of material has been used on pipe to quite an extent and it appears that its use could be profitably extended to shapes, plates, bar stock and rod to preserve mill finish during shipment and storage which often involves exposure to the weather for long periods. Such coatings are durable, transparent, reasonably elastic, resistant to water and wear, and as a rule less expensive than paint. Rough handling and expansion and contraction of the metal have but little effect. There are a few exceptions to this recommendation, such as bar stock fed to automatic machines where this type of coating may interfere with chucking. If so, a plastic product of the heaviest grade would provide adequate protection, although removal with a petroleum solvent would be necessary before machining.

With products such as rod for wire drawing it is entirely possible that pickling could be eliminated by the application of a hard-drying coating at the mill. This would represent a saving in labor and materials.

Other examples might be cited, but as a rule the selection of the proper type and consistency or viscosity grade represents a compromise between ease of application, the severity of the storage conditions and ease of removal. Naturally cost is also a factor, but the difference in cost between various grades is small enough to place this factor in a position of secondary importance. The cost of improper protection is too great for it to be otherwise. Ease of application or removal, while a definite consideration, should also not be permitted to have too great an influence, for generally those products most difficult to apply or remove furnish the best protection.

In conclusion, stress should be laid upon the definite economic advantage to be derived from the use of good rust preventive compounds. Rust removal is expensive. Where remachining is required, a change in dimension results which often requires even more expensive machine work to the companion member. Rusty spare parts have caused the loss of valuable machine hours and even held up plant operation. Good rust preventive compounds are not cheap compared with the cost of other petroleum products of similar consistencies, but a careful analysis of the potential savings to be obtained from their use is very apt to surprise those who have not looked into the matter previously.

RAILROAD RAIL OF FUTURE TO HAVE NEW SHAPE

Most of the railroad rails of the future will have a new shape. This prediction was presented at a metals engineering session of the fall meeting of the ASME by Walter Leaf, research technician of the Denver and Rio Grande Western Railroad.

Preparatory work on the new rail design followed the failure of a 112 pound rail on the main line of the Denver and Rio Grande Western Railroad. The middle section or web of the rail had cracked and then ruptured; a piece dropped out, and the rail broke in two. Twenty-nine rails in adjacent track were found to contain similar cracks. The extent and relative importance of such failures throughout the country is shown by the fact that of all rail failures in control cooled rail between 1935 and 1944, 41.8 per cent were in the web.

The three new rail sections, approved by the Rail Committee of the American Railway Engineering Association and adopted as standard design after several years of experiment, are very similar to the design worked out by the Denver and Rio Grande Western Railroad which is, in effect, the old web turned upside down and thickened throughout. At the present time, most rail mills have made or are making rolls to produce the improved sections.

In investigating the failure, the four major causes of fatigue failure, design, fabrication, metallurgy and mishandling in service, were studied by the research laboratory of the railroad. Design was determined to be the probable cause of the rail failure. The usual rail is almost as high as it is wide, but the 112 pound rail was much higher than its base width.

In the first changes in rail design tested by the company, the web was merely thickened by running straight lines between top and bottom but further changes proved to be necessary. Since web stress is usually highest in the upper portion, the lower portion need not be as thick as the upper. This principle was followed in the new design, which is in effect an inversion and slight thickening of the original shape. Fatigue cracks could be eliminated by rolling a very heavy rail, but the extra cost would not be warranted, and no matter how great the weight, its life would be limited.

Jacking Up a Blast Furnace Shell

. . . . describing the detailed procedure for leveling the No. 5 blast furnace at Sparrows Point while renewing a portion of the shell . . . .

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▲ EARLY in 1941, plans were made and materials ordered for renewing the shell of No. 5 blast furnace from the mantle to a plane at the top just below the bleeder offtake connections, a vertical distance of about 65 ft. This new shell was to be erected outside the old shell, which was to be removed only after the load at the furnace top had been transferred to the new shell. A similar job had been done on No. 6 furnace in 1938.

It was known that No. 5 furnace was not plumb, and measurements taken at the time of the last relining showed that, between the mantle and the tunnel-head, it leaned about five inches on a line roughly north-northeast toward the dust catcher and away from the skip bridge. Tentative plans had been made to plumb the stack by cutting the shell at the first riveted girth seam above the mantle, using eight hydraulic jacks evenly spaced around the furnace. Although brackets had been designed for welding to the outside of the furnace shell above and below this seam to provide seats for the jacks, the scheme had not been worked out in detail.

In 1945 the stack developed hot spots and plans for relining the furnace and renewing the stack shell came up for review. The feasibility of the proposed jacking scheme was called into question, and after analysis it became apparent that extensive reinforcement of the old shell would be necessary to insure safe execution of the plan. The critical feature was the likelihood of buckling of the shell from concentrated and eccentric loading; the shell at the level of the proposed jacking operation being approximately 30 ft in diameter and less than 7/8 in. thick, honeycombed with cooler holes and scarred from 25 years of service.

Several alternative schemes were considered, one of

Presented before AISE Philadelphia District Section Meeting, April 5, 1947

Figure 1 — In this front view of the furnace, taken after completion of plumbing, some of the jacking brackets are visible above mantle.

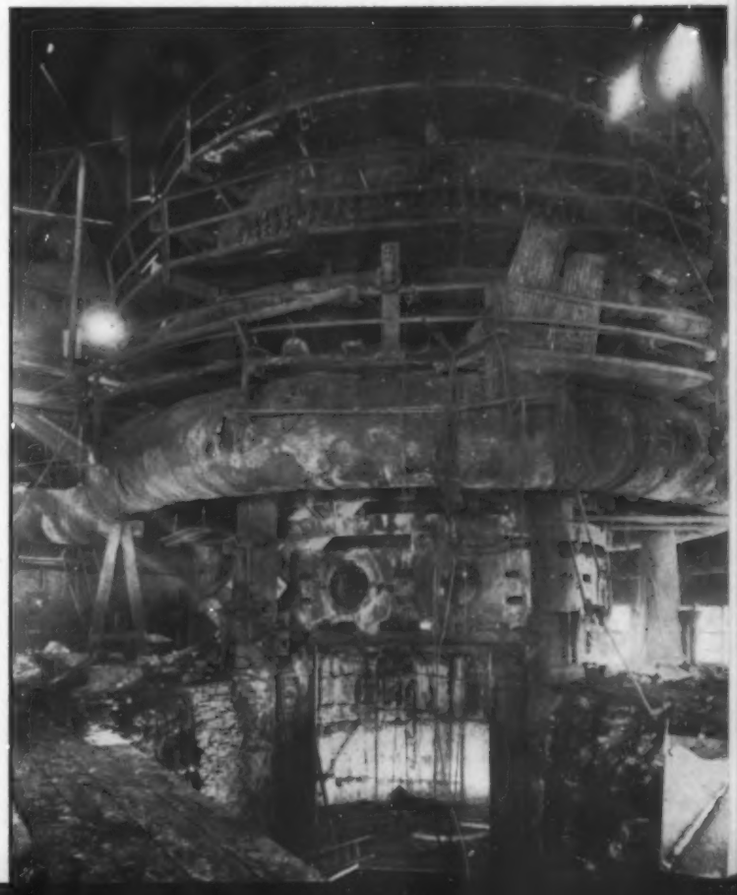

Figure 2 — View of brackets taken from inside of furnace.

which was adopted and successfully carried out. A description of this scheme follows.

At the first seam above the mantle the lower edge of the second ring of shell plates overlapped the upper edge of the first ring by 8 inches, and was fastened to it by three horizontal rows of 1⅛ in. diameter rivets arranged in a staggered pattern so that the vertical rows consisted alternately of two rivets and one rivet. This pattern was repeated all the way around the furnace, there being 224 vertical rows of two rivets each and the same number rows of one rivet each, 672 rivets in all. The slope of the conical shell at this lap was 1 7/16 in. per ft. Figure 1 gives a view of this portion of the furnace.

One hundred and twelve vertical slots, 2 in. wide by 9½ in. high, were cut through these lapped plates; thus removing every other vertical two-rivet group, which comprised one-third of all the rivets. These slots extended ¾ in. above the top edge of the first ring of plates and ¾ in. below the bottom of the second ring. Sixteen of these vertical slots, equally spaced around the ring, were fitted with plugs welded to the outside plates and free to move vertically with respect to the inside plates and designed to prevent, or limit, rotation of the two parts of the shell with respect to each other after the remaining rivets were removed from the seam.

At each of the other 96 slots, a pair of brackets, designed to accommodate a 1½ in. diameter bolt to be passed through the slot at an angle of about 12 degrees to the slope of the shell, were fitted and welded; one to the outside of the second ring and hooking over its lower edge, and one to the inside of the first ring and hooking over its upper edge. Sufficient welding was applied between the edges of these brackets and the shell plates to restore the strength lost from the plates by cutting the slots, and to take part of the load to be applied by the bolts. The remainder of the load was to be taken in bearing between the plate edges and the offset ends of the brackets. The brackets completely covered the slots, but allowed clearance on the adjacent rivet heads.

The brackets were machined from 4 in. mild steel slabs. Each bracket was shaped to hold a spherical washer and its seat, both made of rail steel, and was bored to 2 in. diameter to allow clearance for a small change in inclination of the bolt with respect to the bracket. The bolts were 1½ in. in diameter, alloy-steel studs, with tensile strength of 96,000 psi, and 67,000 psi elastic limit; threaded 7 in. each end with 12 threads per inch, and fitted with hexagonal nuts 2 in. deep. The bolts were 27 inches long and the free length between the nuts before load was taken on them was 22 inches.

After completion of the welding of the brackets to the shell, the bolts were fitted in place and strain was taken on each bolt, (800 ft lb torque on the nut measured by a torque wrench), the total load on all of the bolts being equal to about twice the weight of the furnace structure above the bolts, plus a generous allowance for friction. See Figures 2 and 3.

The next step was to remove the remaining rivets, 448 in all. After this was done, the loads on the bolts were checked with the torque wrenches, shown in Figure 4, and were found to average less than half of their load before removal of the rivets. One-third of the bolts, in two groups roughly opposite each other, were found to be wholly unloaded. The largest group of loose bolts was located toward the east quarter of the furnace in the direction of the dust catcher. The bond between the lapped plates had visibly broken, and the anticipated difficulty due to friction between them faded out of the picture.

The method adopted for plumbing the stack was the result of a search for a means of applying a uniformly distributed vertical force between the edges of the shell plate rings, without introducing bending moments, but while constraining the edges of these rings against radial deflection. Through the use of the 96 bolts uniformly distributed around the ring, a workable approximation of the effects desired was achieved, which

Figure 3 — View of brackets taken from outside furnace after completion of plumbing.

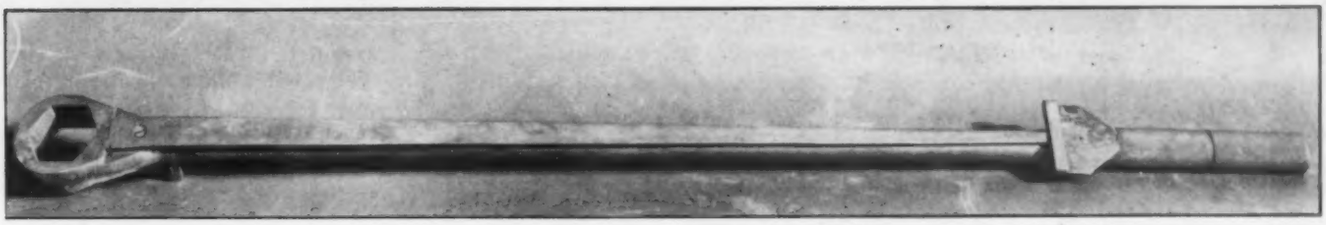

Figure 4 — The pointer of this torque wrench remains straight when the handle bends, and torque is read on calibrated scale.

assured a safe and sure means of doing the job with complete control at all times during the operation.

The effect desired was to tilt that part of the furnace above the mantle so as to make the center of the tunnel-head casting above fall on the same vertical line as the center of the mantle ring below. The plumb line showed that to do this, the top of the furnace would have to move 4¼ in. south and 2⅜ in. west. The weight involved was believed to be about 400 tons. However, the effect of the downcomer pipes was pretty much of an unknown quantity.

The plane of the greatest inclination through the axis of the furnace was found to pass through the shell at points about 30 degrees off the north quarter toward the east end 30 degrees off the south quarter toward the west. If the shell at the first point could be moved upward 2⅛ in. while the second point was held stationary, the top would be forced to move the required distance in the desired direction. To do this in a methodical manner, the 96 bolts were divided into 6 equal groups of 16 each, one group being centered on the point where no movement was wanted, and one on each side of the point where the greatest movement was wanted. The work of raising the load was to be done by these latter two groups and the intermediate groups were to be used to follow-up. The two work groups were to be tightened by torque wrenches, three men to a wrench, and the load on no bolt was to exceed 400 ft lb, while intermediate groups were to be tightened by ordinary box wrenches with short handles, one man to a wrench. The bolts of the group at the point where no movement was wanted were to be tested periodically to ascertain their state of tension and were to be tightened as little as possible.

The work proceeded on this basis until, at the end of 12 hours, it became apparent that all of the slack had been taken out of the downcomers. This was evidenced by increasing difficulty in keeping to the limit of 400 ft lb per bolt in the group of bolts toward the east quarter. By the time the plumb bob had moved through one-third the required distance, the 400 ft lb limit had to be abandoned and the procedure of tightening the bolts was accordingly modified by gradually increasing the loads on the bolts on the east side. At the end of the fourth 8-hour shift, the plumb line hung 1⅛ in. east of the mark, while the loads on the bolts ranged from 800 ft lb at the east to 100 ft lb at the west, and the effect of further tightening was merely to increase this disparity and raise the load without tilting. At this point, it was decided to ease off on the bolts to equalize their loads and then cut the two vertical downcomers on the east side of the furnace. The easing-off resulted in the loads on the bolts being equalized at about 350 ft lb, the plumb bob coming to rest ⅝ in. north and 1 3/16 in. east of the mark.

One riveted seam was cut loose on the northeast and one on the southeast vertical downcomer, after flanges had been welded above and below the seams, and bolts placed between the flanges to limit and control the expected vertical movement. It was expected that the cutting of the vertical downcomers on the east side of the furnace would transfer the full downcomer load to the west side of the furnace, and that the long, sloping downcomers would bend sufficiently to allow the desired movement of the furnace.

Manipulation of the bolts was resumed but it soon appeared that the downcomer load was still a force to

Figure 5 — The scaffolding around the downcomers indicates where they were cut.

be overcome, as tilting came to a halt with the plumb bob 7/8 in. east of the desired position, with increasing loads on the bolts toward the northeast and decreasing loads on those toward the southwest quarter of the furnace. Loads were again eased off and equalized, after which sections were cut from the reducers in the two sloping downcomers just up-hill from the suspender rod connections, a few feet west of the north-south centerline of the furnace, see Figure 5. Then the bolts were again tightened and the plumb bob moved steadily in the desired direction. When the point of the plumb bob hung directly over the mark, the loads on the bolts towards the northeast were still running high; the work on the bolts was therefore continued until the bob had passed the mark. The loads were then eased off and equalized, and after several tries the bob finally hung over the mark and the loads on the bolts were evenly distributed. The final readings on the torque wrenches were less than 300 ft lb.

At the completion of the operation, measurements showed the maximum upward movement to be 2 3/8 in. at the point 30 degrees east of north, and the minimum 1/4 in. at the point 30 degrees west of south where no movement had been desired. The mean upward movement of 1 1/16 in. made up for some of the height lost through buckling of the shell during the life of the furnace. The effect of the operation on the tunnel-head was to reduce the amount the top casting was out of level from 1 9/16 in. to 1/2 in. in 19 ft.

At no time during the operation was any distortion, buckling, etc., noticed from the use of the bolts near the seam where the work was done. However, loud noises, and the falling of clods of scale, etc., which had been stuck to the inside of the stack shell probably indicated strains in the upper shell at the times when loads were accumulated in the bolts on the east side before the downcomers were cut.

Of the 96 bolts used, trouble developed in only one and that was apparently due to some accidental injury to the threads before installation. There was no cramping in brackets, stripping of threads or galling. The lubricant used, white lead and tallow, between nut and bolt and washer and seat seemed to be well chosen and suitable to the purpose. All tightening of bolts was done from the inside of the furnace as this afforded easiest supervision of the operation.

EMERGENCY LOAD CONTROL OF POWER HOUSES

. . . . at small cost, a control system may be installed which will give a simple method of emergency load control in steel mill power houses . . . .

By K. S. KUKA

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▲ REMOTE control of switches and apparatus is today a well established practice in electrical engineering. Several electric supply systems with very extensive networks are equipped with tele-metering and tele-switching with central supervisory control, utilizing the carrier current principles, or the tone-frequency ripple current methods of remote control.

Such systems, however, are economically feasible only in case of vast and widely spread-out supply networks, where quite a number of remote operations are to be performed several times a day, according to a pre-arranged schedule or even in an emergency.

Problems of power generation and power distribution for a large centralized industry, such as an iron and steel works, are quite distinct. The loads are extremely fluctuating and come with extreme suddenness, and it is essential that the powerhouse should be ready to carry the loads as they come at all times. Operating conditions of various rolling mills and steel melting plants are such that even a few minutes power failure causes a comparatively long delay in restarting of the mill, due to cobbles in continuous mills, or heat troubles in other mills, or air pressure failure in bessemer converters.

Powerhouse troubles, though occasional, do occur at times, and cause a great dislocation of the production processes in various plants. A remote control system is therefore of great advantage so that in case of powerhouse troubles, the load dispatcher can either pass on the danger signal instantly, or can selectively trip off some of the mills, which would cause the least possible delay in restarting when normal operation is resumed.

Though the necessity of such a selective load control, either automatic or manual, has been felt for a long time, few powerhouses of large industrial concerns are equipped with such a system; because the standard

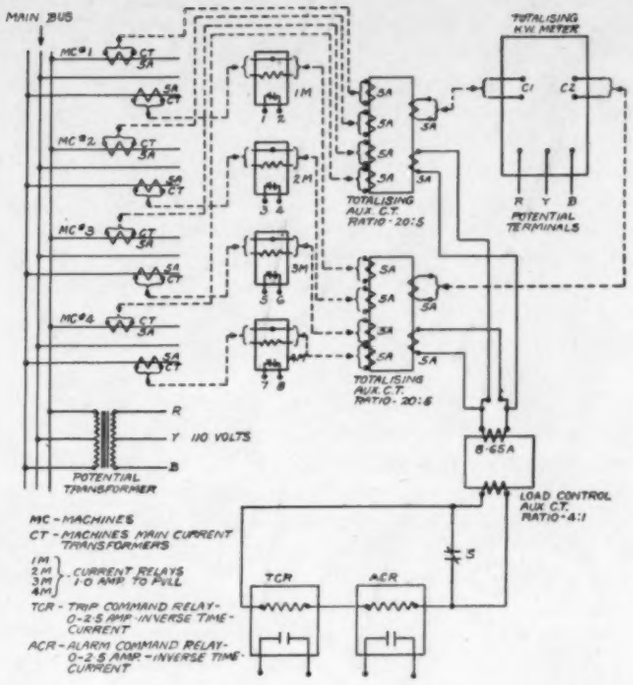


Figure 1 — Wiring diagram for load control relays with an integrating kilowatt-meter for a four machine system.

systems of remote control operations would be prohibitively costly to be applied to the limited supply network of an industrial plant. The system should be flexible, foolproof, quick-acting and selective; but it must also be economical and simple.

This paper describes a system of remote control of the loads, as they prevail in a large centralized steel plant, where it is desired to guard against contingencies and allow the loads to be reduced without causing any great sudden disturbances in the various continuous processes, whenever there is trouble at the main generating station.

The following special eventualities are considered:

1. One of the main generating sets working on a common bus suddenly trips off during heavy load periods, and the overload goes on to the remaining sets, which cannot carry it.
2. Sudden troubles in boiler house, troubles of steam pressure, failure of some important auxiliaries, when it becomes at once necessary to reduce the load on the whole powerhouse to momentarily pass over the emergency.

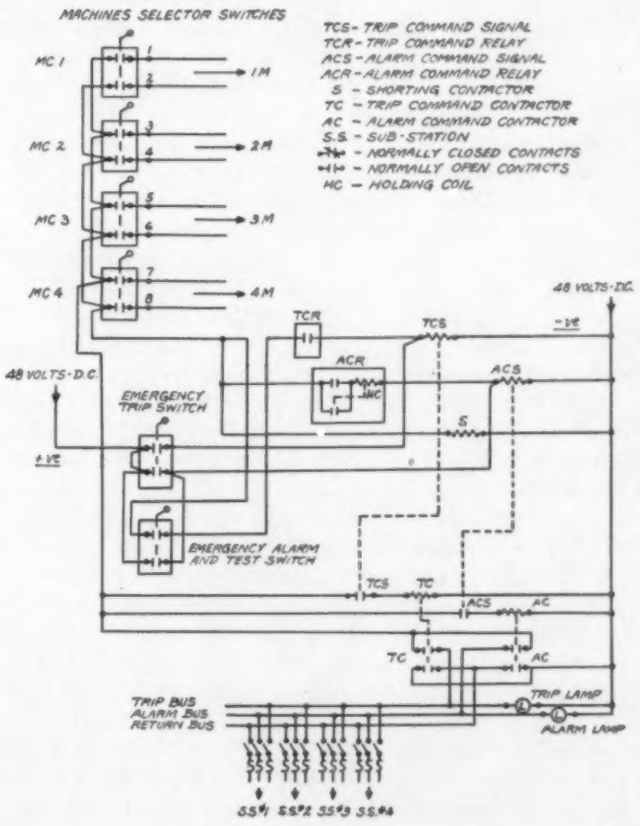
The advantages of the proposed load control system are:

a. It is simple as well as selective, and can be introduced at any time without necessitating any shutdowns, disconnection, or re-adjustment of the main distribution system.
b. Only standard equipment is used which can be installed and wired departmentally.
c. Load controls, both alarm and disconnection, are automatic; and the time taken is inversely proportional to the total loading of the station, in the event one important machine trips off during heavy load conditions.
d. Additional cost involved is very small, particularly when pilot wire relaying is provided for the protection of the main feeders, where a few spare control wires are generally available.
e. Load dispatcher can always send the alarm signals, or the selective tripping commands, whenever an emergency demands the powerhouse load control to tide over a sudden temporary emergency.
f. If at all required, it is possible to provide a standby super-imposed control for alarm or tripping, at important intermediate sub-stations to send signals to various plants, in case of an apprehended total power failure on an important main bus due to overloading, or failure of an important feeder.

WIRING CONNECTION DIAGRAMS

The main connections are shown in the Figures 1, 2 and 3. Figure 1 gives the interconnections incorporated with the totalizing kilowatt-meter provided to indicate the combined loading of the station. The auxiliary current transformers for the totalizing kilowatt-meter are provided with a separate secondary. These secondaries of the two totalizing current transformers are then cross-connected and taken to another auxiliary current transformer, termed "Load Control Transformer," with a winding ratio of 4:1. In the secondary of the latter, the load control relays, TCR and ACR are connected in series. The relays TCR and ACR are standard induc-

Figure 2 — Power house, load control, alarm and trip circuit.



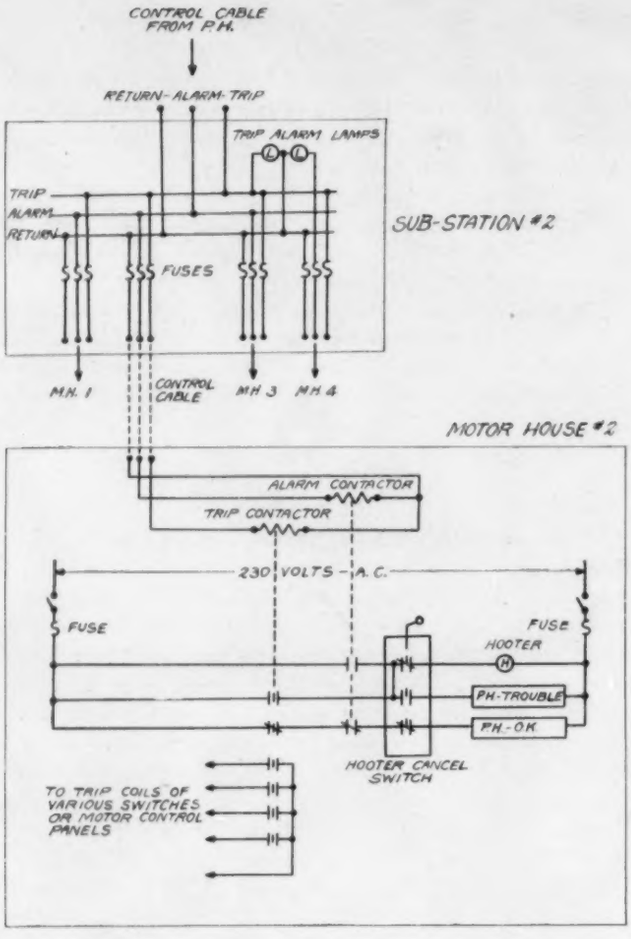


Figure 3 — Alarm and trip circuit at sub-station and motor house.

tion type current relays, with variable current plug setting and time lever setting giving the inverse-time characteristics. There are either "IAC" type, I.G.E., or "CO" type Westinghouse, or "PBO" type Metro-Vick current relays. These relays are normally shorted over a shorting contactor S.

Figure 2 shows the main control circuit for sending the signals from the powerhouse to various substations and mill motor houses. The system is shown for four machines. Any combination of the operating machines can be selected over the "machine selector switches MC." The test and the emergency switches permit either testing, or any emergency signalling.

Figure 3 shows the control provided at the intermediate substations and the motor houses. Illuminated lamps indicate the condition of the powerhouse continuously.

PRINCIPLE OF OPERATION

The number of machines in service is first selected with the help of the selector switches "MC." Suppose machines 1, 3 and 4 are in service, each taking half its full load. As soon as the switches MC1, MC3, and MC4 are switched on, the load control system comes into operation. Current relays 1M, 2M, 3M and 4M (see Figure 1) are designed to pull in at about 25 per cent of the load on the machine. As long as the load on a machine is below 25 per cent, it is not at all necessary to introduce that machine in the load control system.

The relays TCR and ACR are then adjusted. The relays have standard plug settings of 0.5, 1.0, 1.5, 2.0 and 2.5 amperes. The relay ACR is termed "alarm command relay." It transmits the initial alarm command. The relay TCR is termed "trip command relay" and transmits the initial trip command. The settings of the relays are indicated in the following table:

No. of machines in service	*Relay TCR current setting*	*Relay ACR current setting*
4 machines	1.5 amp	1.5 amp
3 machines	1.0 amp	1.0 amp
2 machines	0.5 amp	0.5 amp

The table shows that the relays are set for the full load current of the machines, one less than the number in actual operation at the time. The time-lever of the relays is chosen such that the alarm relay ACR goes into operation much faster, say in "one second," whereas TCR relay will have maximum timing of "four seconds" for 40 per cent overload on the station. The standard overload settings for the machine overload protection relays are 150 per cent load and 6 seconds.

Suppose the load on the station is such that each of the three machines in operation at the time takes three-fourths its full load, and suddenly No. 1 machine trips off, the whole load then falling on the two remaining machines, which means an overload of 12½ per cent for each, supposing all the machines to be of the same M.C.R. capacity.

As soon as No. 1 machine has tripped, relay 1M drops out and makes its contacts, which gives energizing power to the shorting contactor S, which at once pulls in, and puts the ACR and TCR relays into operation. Current in the secondary of the load control auxiliary current transformer will be about 1.25 amp. Plug settings for the three machines will be 1.0 amp. Therefore, the two relays are free to operate. If the overload on the machines tends to persist for say 0.75 sec, the relay ACR makes its contacts and sends the alarm signal. The holding coil HC in the relay ACR maintains the alarm signal once it is given, until the operator sets it right. When the ACR contacts are made, the relay ACS is energized, which in turn energizes the AC contactor, which transmits 48 volt d-c power over the control relays to various substations and mills. Alarm signal lamps provided at the control rooms of the powerhouse and the substations, indicate the trouble to the respective operators, as long as the trouble conditions persist.

At the motor houses, the alarm contactors start "hooters" which can be located at selected spots in the various mills, demanding that the rolling shall be stopped at once. The "hooter cancel switch" puts the hooters off, but brings in an illuminated sign board, located in the motor house indicating powerhouse trouble. As soon as the clearance is given from the powerhouse control room, the "powerhouse — OK" board is illuminated and the mills are allowed to start.

If in spite of the alarm being transmitted, the load does not drop but tends to rise, the "TCR" relay comes into operation and transmits the tripping command to the mills. The tripping contactor at the motor houses is energized, and trips off the various switches pre-selected for operation. The relay TCR automatic-

ally selects its operating time depending on the magnitude of overload, independent of the operator, who is free to attend to putting back the other machine on the line. The disturbance on the whole system is thus minimized and the other machines allowed to function normally without the disturbance passing on to them due to overload conditions.

In the motor houses, it is not at all necessary to trip off the flywheel sets. If the tripping is taken to the mill motor magnetic panels, the rolling will automatically stop, while the re-starting of the mill will be resumed at once without the necessity of re-starting heavy flywheel sets.

There are occasions when due to steam troubles, or other auxiliary troubles, it becomes necessary to reduce load on the powerhouse as quickly as possible. The emergency switches provided on the load control board, permit the operator to send either trouble signals or tripping signals as the occasion demands. He can also select the substations as he wants, by operating the outgoing control cable switches.

The control system, therefore, gives a very simple and selective method of emergency load control of powerhouses in large industrial plants. The cost of introducing the system is small, compared to the advantages gained

REDUCING MAINTENANCE OF COLLECTOR ASSEMBLIES

(*Continued from page 37*)

By C. E. BAXTER

The circuit carried only a small current and therefore, a very light shoe could be substituted. One inch clearance between the lowered shoe and the series of contact plates would be sufficient and the total raise required would be not more than 2½ inches. These conditions indicated that solenoid operated mechanism would be entirely feasible.

One-quarter inch steel plate and flat bar welded together was used to construct a frame about three-quarters as long as the original shoe and designed to fit on the same base casting. The plate formed a platform upon which a piece of ½ inch keystock, serving as a contact arm, was held in place by a single bolt carrying a compression spring between the bolt head and the keystock. This arrangement permitted the contact arm to swing sidewise without damage in case it should be in the elevated position from any cause when the pusher machine was moved. A pull type solenoid with a stroke of 1⅜ inches and a pull of approximately 12 pounds was mounted so as to raise one end of a horizontal lever located about 12 inches below the shoe level. A push rod made in two telescoping pieces and using a compression spring as a cushion formed a link between the solenoid operated lever and the interlock collector arm. A fibre block formed the hinge between the push rod and the collector arm, thus, insulating the arm from ground. Ratios of pull and travel between the solenoid and the tip of the contact shoe were dependent upon the position of the push rod. The push rod was set upon the lever arm so as to transmit a one inch stroke. It was then set upon the collector arm so that it raised the tip of the arm approximately 2½ inches. With this stroke we found there was plenty of force at the collector arm tip to insure a good contact.

The rigging described has been in service on both of our pusher machines for more than six years. We have replaced two solenoid coils and several contact arm tips. A once troublesome maintenance problem has been almost entirely eliminated. The application of course is extremely special but it illustrates the point that simplicity in electrical apparatus is always desirable.

This paper should not be closed without mentioning a very simple change that has saved much labor. The stationary interlock plates mentioned previously are made of cast aluminum. Vapors, dust and gases escaping from the coke ovens caused a hard scale having high electrical resistance to form on the aluminum plates. Cleaning interlock plates became a continuous chore for maintenance men until one of them suggested that we try lead facings on the plates. The lead sheath from a piece of scrap cable was cut into strips which were fastened to the interlock plates with small machine bolts. It was found that the impact of the interlock shoe against the lead facings was just heavy enough to indent the surface slightly thus, cracking off any hard scale that had formed and giving good electrical contact. The lead strips gradually expand and need replacing after about 18 months service but replacing them is a simple matter. Expanded facings are saved until our stock of spares becomes low, when remelting and molding interlock facings becomes a good rainy day job.

Abstracts of papers

TO BE PRESENTED AT AISE ANNUAL CONVENTION

WILLIAM PENN HOTEL, PITTSBURGH, PENNSYLVANIA, SEPTEMBER 22, 23, 24, 25, 1947

TWIN MOTOR DRIVES FOR TANDEM COLD STRIP MILLS

By R. H. WRIGHT, Westinghouse Electric Corporation

▲ THE latest high speed tandem cold mills require from 3000 to 4500 hp for the finishing stand. The top speed of the last set of working rolls may be as high as 900 rpm. Such a combination of power and speed cannot be incorporated in a single armature direct current motor of normal design. It has therefore been necessary to resort to special construction in order to meet these requirements.

Two mills which went into operation this year have twin-motor drives with special gearing for the last two stands. One is a 56 in. four-stand sheet mill designed for 3000 feet per minute maximum speed and the other is a 42 in. five stand tinplate mill having a maximum delivery speed of 5000 feet per minute. Another 54 in, four-stand sheet mill now under construction will have a similar arrangement.

As is usually the case, any one of several drive arrangements could have been used for these mills. The twin-motor arrangement was selected for the more difficult applications because it provided a compact arrangement of the drives and permitted the use of motors of conservative design. Considerable duplication of electrical equipment has been made possible. The possibility of damage to the pinions of the highly powered finishing stands due to errors in matching work rolls has been eliminated. The operation is smooth and quiet. The use of twin-motor drive therefore presents a safe way to apply heavy power at high speeds with simple electrical equipment.

The drive for a skin pass mill presents a somewhat different problem. Since the rolls run dry, there is no lubricant to facilitate slippage of the rolls. On the other hand, it is often desirable to grind the upper and lower work rolls to different shapes. Mechanical slip clutches have been used with pinion drives to provide flexibility to meet these conditions. Two recent 56 in. single stand mills have direct connected twin-motor drives. The design and operation of these mills presented a number of mechanical and electrical problems.

OPERATION AND MAINTENANCE OF VARIABLE VOLTAGE CONTROL SYSTEMS

By A. D. HOWRY, Assistant Superintendent, Maintenance, — Electrical, Alan Wood Steel Company, Conshohocken, Pennsylvania

▲ VARIABLE voltage control, as used in the steel industry, is not new having been used since the inception of the reversing electric drive. Subsequent applications are too numerous to tabulate, and do not enter into the tenor of this study.

In recent years the rotating regulators of the amplidyne, rototrol, and regulex types have been perfected and applied to the variable voltage drive, resulting in simplicity, flexibility, smooth and exact control, and lower maintenance. A number of papers have been presented and published by the Association of Iron and Steel Engineers on the design and installation of variable voltage control drives. These papers, together with technical publications furnished by the manufacturers, have enabled the steel plant technician to become familiar with this type of equipment.

This study therefore is based on the operational functions of variable voltage control, covering circuit analysis, trouble shooting, preventative, and corrective maintenance. The criterion of maintenance is operational availability and perfection, therefore the technician must be thoroughly familiar with his equipment and its functions.

To become familiar with the subject, we must consider:

1. What is variable voltage control?
2. What are the benefits of variable voltage control?
3. How does it differ from other control?
4. How does it operate?

Familiarity with the equipment and its functions therefore reverts to the application of this knowledge in:

1. Preventative maintenance.
2. Corrective maintenance.

The first, preventative maintenance, as the name implies, consists of overhaul checking and testing during the shutdown period to insure continuity of operation during the production period.

The second, corrective maintenance, again as the name implies, consists of emergency repairs of faults which occur during production. Here the time element is paramount and delays must be minimized, making temporary repairs or connections if necessary which naturally must be corrected later during the shutdown period.

Corrective maintenance requires the maximum application of knowledge of the system. The trained technician can by simple tests and deductions normally isolate the difficulty, make the necessary repairs, and return the equipment to service with a minimum of delay.

Analysis of the circuits show that although they have the appearance of complexity, they are relatively simple when broken down into component parts, the basic circuits being a generator and motor permanently connected together into a closed circuit, all control of speed, acceleration, deceleration, and reversal, being

accomplished by field manipulation. This field manipulation is accomplished by various methods, depending on application. The simplicity of the circuits and maintenance thereof is shown in step by step detail.

IMPROVED REVERSING MILL D-C GENERATORS

By C. LYNN, Manager, D-C Engineering Department, Westinghouse Electric Corporation and W. H. Burr, Electrical Superintendent, Lukens Steel Company

▲ BY the use of laminated steel frames instead of conventional solid steel frames, improved operation can be secured, particularly in reduction of sparking during transient load changes on reversing mill d-c generators.

Proper design of the commutating and compensating field windings and shaping of the commutating pole tips will produce a field beneath the commutating pole under steady state conditions that will practically nullify the armature fields. Such machines will carry their rated load and even overload with sparkless or almost sparkless commutation, until saturation of the commutating poles occur. This point, in ordinary d-c machines, may be reached at 1½ to 2 times rated load. On reversing steel mill d-c generators, however, specially designed commutating poles are used, and saturation does not occur until about 3 times load is reached.

During transient conditions, such as occur when a reversing mill motor is accelerating or decelerating, or whenever the load current is rapidly changing, the magnetic field set up by the commutating field winding may not be in phase opposition to the armature fields. The armature magnetic structure is always made of laminated steel punchings, because the current in the armature coils is alternating until it has been commutated. Thus the armature flux is practically in phase with the armature current. However, the frame structure of the conventional d-c machine is always of solid steel and any change of flux in this solid steel structure is retarded or held back by the eddy currents produced by the change of flux. When the load current is changed rapidly on a conventional type of d-c machine, the commutating pole flux lags behind the commutating field current. This results in sparking at the brushes much more severe than occurs with the same load current under steady state conditions. This has been known for many years, and in the past some d-c generator frames have been laminated, primarily, to secure fast response of main pole flux particularly for exciters. In a few cases, laminated frames have been used to improve commutation, but usually the thickness of laminations has been too great.

If a relative speed of 1 is assigned for solid steel frames, then ½ in. thick laminations have a relative speed of 25 to 50, ¼ in. thick laminations, 200 to 250, and 0.0172 in. thick laminations, above 50,000. These are ideal figures with definite insulation between each lamination, and on the basis of no structural obstruction such as clamping bolts, welds, etc., which will reduce these values materially in an actual frame structure by short circuiting the laminations. An actual resultant relative final speed of 25 to 100 times that of solid steel will give wonderful improvement in transient load commutation on large size d-c machines.

On some 2000 kw reversing mill d-c generators with laminated frames placed in service this year, under the worst rolling conditions light sparking occurred on only a few of the brushes with complete absence of heavy sparking and streamers. The corresponding commutation on older and equivalent large machines using solid frames with the same rate and percentage of load change, gave heavy sparking at the edges of all brushes, some streamers and even an audible "hiss" or "sing" occurred at the brushes the instant the "spit" occurred.

FACTORS IN THE OPERATION OF A MANNESMANN PIERCING MILL

By H. R. McLAREN, Timken Roller Bearing Company

▲ THIS paper covers the piercing operation on the Mannesmann piercing mill, which, while not the only type piercing mill, is the most commonly used mill from the standpoint of the number of units and tonnage produced.

Seamless tubing requires the best quality steel, and proper surface conditioning of the billets. Prior to piercing, the billets must be centered to keep eccentricity to a minimum. Heating usually is done in either the longitudinal, sloping-hearth furnace or the rotary furnace. The latter can maintain a heating rate of 20 minutes per inch of diameter which is two-thirds that required by the former furnace. Billets are heated to a temperature from 1780-2300 F depending on the steel.

Guiding during the piercing operation is one of the most important items in obtaining quality in the finished product. Guides are divided into: inlet guides, mill guides-top and bottom shoes, and outlet guides-tube and bar. The fundamental axiom in guiding is that the centerline of the work piece must remain in a straight line in all movements from solid to tube during piercing.

Piercer rolls are dressed with a double conic surface, and the large part of the cones meet at the center or back of the center of the roll.

The piercer points are another fundamental element in the design of the tube mill. The most important item in plug design is the length of the working surface which determines the rate of reduction from solid to tube.

After all the details of the various parts of the piercing mill are determined, the final step in production is setting the mill to produce the best pierced billet.

APPLICATIONS OF THE BASIC PRINCIPLES OF ROLLING IN ROLL DESIGN

By ROSS E. BEYNON, Carnegie-Illinois Steel Corporation

▲ ROLL design goes back many years and developed with the design of the mill. For a long time it was an art rather than a science and many today still regard it as such. One of the earliest roll designers was that versatile artist Leonardo de Vinci.

This paper traces the history of roll design through

the ages, and then discusses the basic principles of rolling as they are accepted today. The basic principle of hot rolling is that hot metal which is reduced in a pair of rolls elongates and spreads in proportion to the reduction accomplished. The spread, normally, is only a fraction of the elongation. The control of the elongation and spread is the fundamental object in the art of roll design.

Illustrations are given in the paper of the application of this objective in designing passes for bars of all kinds, such as rounds, squares, and shapes, such as standard and universal mill beams, standard and special channels. The paper discusses the passes on blooming, billet, and finishing mills, and the influence which elongation and spread has in the rolling of each section.

The paper is profusely illustrated to show the application of the principles to the examples which are discussed.

NEW TECHNIQUES IN CONDITIONING STAINLESS STEEL

By A. E. HAMILTON, JR., Hamilton Pump Company, Inc.

▲ EMPHASIS today is being placed more and more and more on all types of finishes, and particularly on those used in decorative fabrication. Stainless steels normally fall into the last category. In order to obtain these better finishes, careful conditioning in both the hot and cold rolled stages is essential. The paper describes two new machines which have been developed for thus conditioning steels.

The first machine is an automatic machine for conditioning blooms, billets, slabs and sheet bar. One important effect in the use of the machine is that variations in grinding due to the human element are eliminated and a better product attained. Wet grinding, which is a feature of the machine, also smothers the injurious grinding dust. Wheel economy is attained, and production performance is increased by the use of the machine.

The second machine has been designed for grinding and finishing of strip and sheet. This machine is used to provide an intermediate grinding operation for the removal of metal surface defects prior to additional cold reduction, it also provides a scouring action which adds to surface uniformity prior to final rolling; and it provides a polishing and buffing effect for high lustre and mirror finish after final rolling.

THE POWDER PROCESS IN STAINLESS STEEL PRODUCTION

By E. M. HOLUB and C. J. BURCH, The Linde Air Products Company

▲ THIS paper describes the value of the powder-scarfing and cutting process in stainless steel production. A brief history of the problems involved in the development of the process are presented, along with a description of the present apparatus. In describing the utility of the powder process in the stainless steel industry, a piece of steel is followed along its line of production from the time it is born in the electric furnace until it emerges as a finished sheet, bar or shape. The uses of the process on stainless steel in every form, ingots, blooms, billets, bars, are described and illustrated. The paper presents accurate time and cost data for specific examples of powder-scarfing and cutting applications. These cost figures were obtained from reports prepared by steel mill industrial engineering departments. In addition to the process applications, a brief summary is included as to the effect of the process on various grades of stainless steel.

USES OF OXYGEN IN STEEL PRODUCTION

By J. H. ZIMMERMAN, Manager of Development, The Linde Air Products Company

▲ WITHIN the past year there has been a tremendous interest on the part of the steel industry and those associated with it in the use of oxygen to increase open hearth steel ingot production. During this time, intensive test programs have been carried on in many mills to properly evaluate oxygen utilization. This has resulted in the adoption of oxygen as a production tool in a number of open hearth shops.

Concurrently detailed experimental work is also being carried on in the application of oxygen to carbon and stainless steel manufactured in the electric furnace, but this paper is confined only to the open hearth application.

The use of oxygen in the open hearth falls into two categories, that of meltdown and decarburization. Since low purity oxygen and/or compressed air were not available in sufficient quantity, oxygen used in practically all of this work described was of high purity, supplied through liquid oxygen distribution systems whose great flexibility permitted use of the large volumes and high demand rates required. Simultaneously a program has been under way at the Homestead works of the Carnegie-Illinois Steel Corporation to determine the effect of various oxygen purities. This work is reported in another paper at this same meeting.

For meltdown, the chief interest has been in the use of oxygen with oil or tar fired end burners. Many designs of end burners have been tried out. These ranged from models using a low velocity oxygen annulus surrounding the steam atomized fuel jet to those using a supersonic velocity oxygen jet below and parallel to the fuel jet. It is this latter design which has shown the greatest promise. By using oxygen in conjunction with the end burners, it is possible to increase the fuel rate while at the same time shortening the flame to such an extent that it will not go into the downtakes. With the oxygen under the fuel jet an area of higher flame temperature and greater radiation is obtained on the bottom side of the flame, while the top side of the flame which radiates to the roof is practically identical with normal firing conditions. With end burners of this type decreases in charge to tap time have averaged 10 to 25 per cent with a range of 400 to 750 cu ft of oxygen used per ton of steel. The end burners are particularly valuable where relatively high percentages of cold metal are charged.

A second method for meltdown of scrap charge is also in the process of development, although to date it has not received as much attention as end burner application. This involves the use of a supersonic velocity oxygen stream to oxidize a small portion of the preheated scrap in much the same manner that a piece

of carbon steel is cut with the oxygen jet. This oxidation, being an exothermic reaction, provides sufficient heat to melt adjacent scrap. The oxygen stream is introduced into the furnace by a water-cooled device having a divergent bore nozzle which imparts the high velocity. Rapid meltdown is obtained by this method, with oxygen consumptions in the order of 22 to 36 cu ft per ton. In using this method, however, care must be taken that the furnace and the scrap are at a high enough temperature so that a freeze-up on the bottom will not result.

A third method has also been used as an aid in meltdown which consists of introducing oxygen into the checkers to enrich the air blast to the furnace. Results are inconclusive although somewhat improved working of the heat has been claimed.

The use of auxiliary oxygen-fuel burners for scrap meltdown has also been tried on a limited basis, with indications that promising reductions can be effected in charge melting times. However, further development of this method will depend upon design of practical means for mounting and mechanizing burners for roof, backwall, or frontwall operation.

After the scrap charge has been melted down and the hot metal is added, oxygen again comes into the experimental picture for decarburization of the melt. Decarburization is being accomplished either by the use of consumable lance pipe or a non-consumable water-cooled jet device. The consumable lance is introduced into the melt with the end of the lance at the slag-metal interface. A slightly different technique is used with the jet device. In this case, the end of the jet device is held 3 to 6 in. above the slag line and oxygen is introduced into the bath through the action of a supersonic velocity oxygen stream which parts the slag and blows well down into the molten steel producing agitation throughout the whole bath. The rates of carbon reduction obtained are approximately the same, although the non-consumable device will lend itself much more readily to mechanization of the process. The rate of carbon reduction, of course, will vary with the carbon content of the steel. At high carbon contents, the reduction rate may be as high as 2 points per minute. Even with carbon contents of 15 or 20 points, the rate of carbon drop using oxygen will be of the order of 1 point a minute. On the average, 100 to 300 cu ft per ton of oxygen are required for decarburization, and savings of heat time of 10 to 20 per cent result.

This paper summarizes the present knowledge of this subject, based upon the results of more than 6000 heats in 34 shops.

STEAM GENERATION AND MAINTENANCE OF POWER STATIONS

By JOHN J. ALEXANDER, Republic Steel Corporation

▲ THE paper gives a brief description of the steam generating facilities of a steel plant where the several boiler stations are interconnected to provide distribution of the steam throughout the steel plant. The method of operation to provide the optimum use of waste fuels is outlined.

The procedure used when making inspections of the steam-driven equipment is also discussed. The necessity for establishing a comprehensive maintenance program for all power station equipment, if reliable steam and electric power generation and operation of blast furnace blowing equipment is expected, is also outlined.

MODERN DESIGN OF MULTIPLE FUEL STEAM UNITS

By A. R. MUMFORD, Development Engineer, Combustion Engineering Company, Inc.

▲ SOME of the more important factors which influence the availability of steam-generating units are discussed in the paper. The steps taken by the designer to lessen the restrictions imposed by some of the factors in the steel industry are discussed.

Slag has been examined in some detail and the control of its deposition is improving through the use of cooling screens, burner position, and perhaps the relation of the area of the flame envelope to the water-cooled area of the furnace. The effect on the viscosity of coal-ash slags of the addition of blast furnace dust is discussed. The blast furnace dust decreases the slag viscosity and increases its stickiness or tendency to adhere to heat absorbing surfaces. This tendency can be offset, at least in part, by conservative design and provision for cooling after the slag particle leaves the reducing zone of the flame. The use of effective shielding to protect uncooled parts of the firing equipment from the radiation of the flame of other fuels in furnaces arranged to burn more than one fuel improves availability and decreases maintenance. Improved control of water conditioning is necessary as the design pressures and temperatures of steam generators rise. Although water conditioning is an operating problem, the designer is interested because of the effect of poor conditioning on availability. To meet load variations at high pressures the designer must depend increasingly on the ability to change the heat input rapidly rather than on the flywheel effect of a large mass of boiling water. The application, within limits fixed by local conditions, of design improvements for increased availability is shown by six late designs of steam generators for the steel industry.

ELECTRIC HEATING OF STEEL STRIP FOR CONTINUOUS PROCESSING

By F. E. ACKLEY and A. R. RYAN, Industrial Heating Division, General Electric Company, Schenectady, New York

▲ THE development of the continuous strip mill has created a large demand for steel strip. Much strip must be heat treated or processed before being utilized in manufacture. Batch type furnaces are commonly used for treating coils of strip, but for some applications a more uniform product can be obtained by continuous heating of the strip.

This paper deals solely with methods of electrically heating strip steel. Metallurgical results and process results are not considered.

There are three basic methods of heating strip electrically:

1. Furnace heating — in which strip passes through a furnace. The transfer of heat to the strip is dependent

upon radiation and convection. These furnaces may be of the roller hearth, catenary, or tower type.

2. Resistance heating — in which the strip is heated by the passage of an electric current through the strip. The heat is generated directly in the strip, and such installations are usually of the tower type in order to obtain a sufficient length of strip between the contact rolls without the utilization of an excessive amount of floor area.
3. Induction heating — by high frequency current induced into the strip. As in the case of resistance heating, the heat is generated in the strip, but no contact rolls are required. The inductor coils surround the strip.

The special considerations peculiar to each type of strip heating are discussed in the paper and the major advantages and disadvantages of each type will be presented.

TRENDS IN LIFTING MAGNET DESIGN AND APPLICATION

By JOHN D. LEITCH, The Electric Controller and Manufacturing Company

▲ THE paper deals with some recent improvements in lifting magnet design, and stresses the advantages of the all-welded construction over earlier designs in which both the inner and outer pole shoes are bolted to the magnet case.

The importance of designing a magnet with as high a coil space-factor as possible is discussed. The all-welded magnet permits the designer to make considerable improvement in this regard.

The effect of duty cycle on temperature rise, and the consequent reduction in ampere-turns is illustrated graphically. Some recommendations are made regarding the operation of a lifting magnet, stressing the importance of holding the percentage of the time that the magnet is energized to a minimum, in keeping with overall efficiency in the handling of materials.

One of the important problems encountered by the designer of lifting magnets is that of sealing the coil and leads against moisture. The use of a thermo-setting insulating compound in place of the old thermo-plastic compound such as asphaltum has definite advantages. Designing the coil as a separate unit, with an all-welded hermetically-sealed steel enclosure, in place of an open coil held in place with screws at gasketted joints is a big step in the elimination of the moisture problem.

Typical applications of circular general purpose lifting magnets are illustrated along with those designed for special applications. In particular, circular magnets are used singly and in pairs in handling scrap, pig iron, rails, billets, coil strip, etc. They are also designed with smooth bottom construction and continuous duty coils for separator service or with extra deep cases and 75 per cent duty coils for skull-cracker service. Rectangular magnets are also used singly and in pairs for handling billets, rails, plates, and pipe. A special purpose magnet of single or double bi-polar design is used widely in handling coil strip steel on end.

FIBROUS GLASS ELECTRICAL INSULATING MATERIALS

By HARRY O. COLLIS, Electrical Engineer, Electrical Sales Division, Owens-Corning Fiberglas Corporation

▲ DESIGNERS of electrical equipment are always searching for materials which will enable them to build better machines; smaller, lighter, more dependable and longer lasting. The user of electrical equipment needs better equipment to eliminate costly down-time, production delays and high maintenance costs.

The use of glass as electrical insulation is as old as electricity itself. The early experimenters used glass for their Leyden jars and voltaic cells. Pin insulators made of glass are still in use on many transmission lines.

Glass has many properties which are desirable for electrical insulation. It is structurally strong and is stable under extremes of temperature and humidity. Glass is an inorganic material and is as ageless as the sand from which it is made.

Glass in fiber form became commercially practical about 1938. About that time a process was developed for producing glass fiber yards in two forms, staple fiber and continuous filament. The staple fibers are relatively short and produce a yard which looks somewhat like cotton or wool. The continuous filaments are of very great length, and the yarn looks like silk or rayon. About 95 per cent of all glass fiber electrical insulation is of the continuous filament type.

Laboratory tests show that glass fiber textile materials are very strong and that a portion of the strength is retained up to a temperature of 1000 F. Electrical tests show good insulation properties, particularly when the glass fiber materials are compared to other insulation under high humidity conditions. Chemical tests show good resistance to deterioration under exposure to chemical fumes and corrosive vapors.

Laboratory data is substantiated by field experience in factories, mills and coal mines. Many motors exposed to the most severe operating conditions have been rewound using glass fiber insulating materials. Records on these tough jobs show that motor failure is reduced through the use of glass fiber insulating materials.

In one mill, a series motor used to drive charging equipment failed about twice a week. The failure was the result of overheating caused by exposure to the furnace heat. The series field was rewound using glass fiber insulating materials and the motor has run without failure for more than two years.

New developments promise even better utilization of the inorganic properties of glass for insulating materials. The perfection of silicone impregnants and lubricating materials makes possible extremely small, light electrical equipment. The properties of the silicon material complement glass fiber to produce an outstanding heat and moisture resisting insulation.

Experimental production of extremely small diameter glass fiber promises a more versatile insulating material. A pilot plant is now in operation treating glass fiber to produce an insulation which can be used at temperatures up to 1800 F. A new method for reinforcing plastic materials with glass fiber mat has been developed and a pilot plant is in operation.

These and many other developments point toward

better, low cost insulation made of glass fibers. These new products will extend the application of the glass fiber products now being used in dependable long life electrical equipment.

INDUSTRIAL USES FOR SYNTHETIC LUBRICANTS

By WM. H. MILLETT, Research Chemist, Carbide and Carbon Chemicals Corporation

▲ IN recent months considerable interest has been expressed in various types of synthetic lubricating oils. This paper deals with a family of non-hydrocarbon synthetic lubricants which may be described chemically as polyalkylene glycols and their derivatives.

The properties of these synthetic materials are briefly reviewed. Such pertinent characteristics as viscosity, viscosity-index, flash points, pourpoints, and specific gravity are described, and the essential differences between the synthetic and hydrocarbon oils are discussed. Of interest in this connection are the non-sludging characteristics, burn-off properties, minimum effect on natural and synthetic rubbers, and the inter-solubility relationships of the synthetics with various solvents.

Detailed observations relative to the use of the synthetic lubricants in industrial equipment are reported. The utilization of these synthetics as hydraulic oils, components of fire resistant hydraulic fluids, high temperature lubricants, and metal forming lubricants are considered to be particularly noteworthy to those affiliated with the iron and steel industry.

Among the applications which are discussed are the following: hydraulic oils for machine tools and hydraulic pressure equipment; components of low-flammability fluids in die casting machinery, floor manipulators, and hydraulic presses; glass manufacturing machinery lubricants, graphited high-temperature lubricants, high-temperature packing impregnants, liquid bath oils, and metal or wire drawing lubricants. Other uses which are mentioned briefly include the use of the synthetics as lubricants for rubber, electric motors, vacuum pumps, and equipment operating at low temperatures. The utilization of the synthetic oils as the base lubricant for low and high temperature greases characterized by exceptional stability and applicability over wide ranges of temperature is described.

BARIUM LUBRICATING GREASE

By C. J. BONER, Chief Research Chemist and G. W. MILLER, President, Battenfeld Grease and Oil Corporation of New York

▲ UNTIL the last few years lubricating engineers were limited in their choice of lubricating greases to those which were water-resistant, but with low melting point; or, those which had high melting points, but were not water-resistant. Since the introduction of barium base lubricating greases, there is available one grease which is both water and heat resistant. This type of lubricating grease also has other qualities which make it preferable for not only most industrial uses but also for automotive and farm-machinery lubrication. These qualities are: sufficient cohesion so that it does not drip, ability to maintain consistency on bearings (in fact at temperatures about 350 F it becomes somewhat heavier), sufficient adhesion so that it resists centrifugal action such as occurs in universal joints, consistency soft enough so that it can be pumped with ordinary power-operated grease guns at temperatures as low as 35 F and by hand guns at a lower temperature, rust-preventative qualities, and finally a melting point well above 400 F.

The above qualities thus provide a lubricating grease which has a much wider application than other specific greases. Eastern steel mills have records of numerous applications of this lubricant, and a western steel mill is a regular user of barium lubricating greases. Mining companies, smelters, construction projects, as well as packing and canning companies have standardized on this lubricant.

As an indication of the versatile nature of this grease, in automotive applications one lubricating grease can be used for chassis, wheel bearings, water pump, and universal joint lubrication. The advantages of an all-purpose lubricant are quite evident, for with one drum of grease instead of several, less space is occupied and greater cleanliness is possible. Further, there is little chance of using the wrong type of grease. Service stations have found an economy in using this lubricant in that about two-thirds as much 4-in-1 barium is required as of all other greases to lubricate a given number of cars. To date, several million pounds of this lubricant have been used for automotive lubrication with outstanding success.

METALS IN SERVICE

By P. M. HESS, Safe Harbor Water Power Corporation

▲ THE author presents in text and illustrated form many of the annoying problems encountered with the use of metals in the hydro-electric field and explains some satisfactory procedures used to combat and rectify them. The value of cooperation and exchange of ideas between the engineers, manufacturers and customers in the solving of such problems is stressed. The present service demanded from metals, and the duties assigned to them are reviewed, followed by a forecast of some of the industry's future problems, suggesting the possibility of a combination of metals and plastics as a satisfactory solution. The effect of the different conditions present in our various climates on the serviceability of metals and the selection of different types of materials to perform or function satisfactorily against these elements are discussed.

Some of the more difficult conditions experienced are illustrated, emphasizing the more important ones, particularly, corrosion and pitting resulting from cavitation. A long program of tests on protective coatings for metals is described, and some of the more recent findings enumerated. The author's experience with combating pitting from cavitation and the solving of this troublesome condition by correcting the source and applying metals capable of withstanding the forces present are related.

Emphasis is placed upon the correct selection of

materials and protective materials on all initial installations to eliminate costly maintenance and consequent related outage later. The paper is finally summarized to show, in a tabulated form, what has been learned by experience and experimentation and stresses what "must be done" to satisfactorily apply corrective measures.

PRINCIPLES OF JOB SCHEDULING IN A MACHINE SHOP

By L. E. FULLER, JR., Carnegie-Illinois Steel Corporation

▲ A discussion of the basic principles of job scheduling is predicated upon certain assumptions that must be made and accepted prior to the development of a procedure for specific applications of job scheduling. These assumptions encompass the general functions of a central order-control agency that assists immensely in presenting the shop order in a form that eliminates a considerable amount of pre-planning which would otherwise have to be developed by the shop.

A brief discussion of these assumptions include:

1. Determination of material requirements.
2. Procurement and availability of material.
3. Development of requests for repair and maintenance work to determine:
   a. Method of operation.
   b. Sequence of operations.
   c. Quality and quantity of requirements.
   d. Operational time allowances.
4. Preparation of forms to adequately provide the transmission of order information.
5. Development of a preferential order system to establish a sequence of order processing.

The general principles of order control as applied to the mental attitude of shop supervision are presented in an attempt to prepare the supervisor for the problems that arise from the development, installation, and maintenance of a scheduling system. Any system, regardless of the simplicity or complexity of development and installation, presents new problems during the period that it also eliminates many consistently irritating problems of production.

The specific principles of order control are discussed in two parts: scheduling, the planning of work to be done; and dispatching, the control of work to be done. Each part is developed to include:

1. Scheduling factors.
   a. Control of orders.
   b. Machine loading.
   c. Assignment of due dates.
   d. Adjustment of machine loading.
2. Dispatching factors.
   a. Control of material.
   b. Release of scheduled orders.
   c. Control of material movement and shipment.
   d. Observation and record of order progress.
   e. Observation and record of the time taken on each unit of work in process and comparison with the time allowance as planned.

The paper is concluded with the development of an outline of a system of order scheduling for a machine shop that can be modified and revised for any particular application desired.

COKE OVEN MACHINERY

By RAGNAR BERG, Koppers Company, Inc.

▲ THE purpose of this paper is to briefly describe the constructional and functional features of the machinery used in the operation of a coke oven battery. To better realize the progress made, a short review of early types may be helpful. Hand labor was at first replaced by very primitive machines, such as the Hibb coke drawer and welsh drag. Modern plants are equipped with larry car, pusher machine, door extractor, coke guide, quencing car, and reversing machine.

The larry car transfers the coal from the storage bins to the ovens, and may be of the gantry type or low frame construction, designed to discharge the coal by gravity or by mechanical feeders. Modern larry cars are usually equipped with adjustable measuring devices, scales, and means for electrically operating the storage bin gates.

The pusher machine levels the coal charge, handles the doors, and discharges the coke from the ovens. The latest type is made of all welded construction with ram head of cast steel and a lattice girder ram to prevent bowing in cooling. The ram is driven by rack and pinion, and the various speeds during the pushing cycle are automatically controlled. The leveler bar is actuated either by pin and sprocket or the conventional cable and drum device. A door extractor is usually mounted on the main platform of the pusher. This machine removes and replaces the doors, and both motor operated and hydraulic machines are in use. Various devices have been developed for the loosening and tightening of the door latches to conform with the door construction.

The coke guide is coupled to the coke bench door machine, which provides the traction drive. Modern coke guides are of the racking type and are provided with automatic doors in the sides which close during pushing.

The coke side door machine performs the same function as the door extractor on the pusher machine, but travels on rails on the battery bench under its own power, and also turns the door at 90 degrees to facilitate cleaning. Various signal systems have been developed to assure correct alinement between the pusher machine and the coke guide.

The quenching car, which conveys the hot coke to the quenching station and discharges the quenched coke on the coke wharf, is provided with electrically or pneumatically operated discharge gates often built of cast steel plates. While some operators still favor cast iron plate in the sloping bottom, all-welded cars of abrasion resisting steel have been built and are giving excellent service.

A very important piece of equipment for the proper operation of a coke oven battery is the reversing machine, which opens and closes the air, gas, and waste gas valves at proper intervals. This is controlled by an electric timing device.

Any future development of coke oven machinery will have for its purpose to reduce the number of manual operations and improve working conditions.

HIGH TOP PRESSURE OPERATION OF THE PIG IRON BLAST FURNACE

By B. S. OLD, E. L. PEPPER and E. R. POOR, Arthur D. Little Company

▲ THE mechanical difficulties that hampered the first trial operation of a pig iron blast furnace on high top pressure have been almost completely eliminated by experimentation during the recent high top pressure operations. Two furnaces of the Republic Steel Corporation have been operated continuously on top pressure for a period of twelve months with the exception of a return to normal top pressure on one of the furnaces for two months due to bell erosion.

Results of this operation, presented in detail, by J. H. Slater of the Republic Steel Corporation in a paper before the 1947 meeting of the American Iron and Steel Institute, showed an increase in iron production of 11 to 20 per cent, a 13 per cent reduction in coke consumption, and a 30 per cent decrease in flue dust produced. Operating data since the Slater paper will be presented in some detail in this paper.

Although very few parts of the blast furnace plant escape mechanical changes during a conversion to permit high top pressure operation, the majority of the alterations are relatively minor in nature. These changes are easy to engineer and construct and, exclusive of new blowing equipment, are inexpensive. The new features require little attention once installed and maintenance costs will be small once the few remaining minor difficulties are ironed out. Past experience can be a great help in making new conversions, and while it is doubtful that the present conversion time of five to seven days will be much reduced, the elimination of minor construction problems will make the conversion of a pig iron blast furnace for high top pressure operation a very routine procedure.

SOME ASPECTS OF LUBRICATION EQUIPMENT MAINTENANCE

By ROBERT A. KRAUS, Republic Steel Corporation

▲ IN this paper the author is concerned primarily with the modern control and organizational method being employed in obtaining correct lubrication, and its related and corollary functions rather than with the what, where and how phase of lubrication. Included in the subjects covered in detail are the benefits to be gained by the construction and operation of lubrication repair organizations and repair stations. Among the items reviewed are the types of work usually performed by these groups including the related tasks such as hydraulic equipment, etc., a discussion on the preferred locations of those stations with respect to other facilities and shops, and the types of test and repair equipment usually found to be necessary in the normal scope of their repair functions. Slides exhibiting types of units now in operation are to be shown.

A similar resume is presented covering the convenience value as well as the return possible in the construction and operation of a separate and distinct organization known as a bearing repair station. The nature of the work performed in these stations in the reclamation and repair of large back-up roll bearings and other bearing of the larger than ordinary type is reviewed. Types of equipment generally found necessary for the cleaning, inspection, repair, reconstruction and storage of these bearings is considered, and the nature of the repair work is discussed. Work on large oil film sleeve type back-up roll bearings is also considered, and benefits to be gained therefrom are demonstrated. Preventative repair is frequently formed due to the nature of the scheduling systems employed in conjunction with the repair phase of the repair stations.

The improved control of general mill lubrication which is possible with adequate well prepared schedules is discussed. The value of properly applied industrial engineering time studies in conjunction with these lubrication schedules and surveys is brought out. Where previously it had been the prictice to have an oiler per turn per mill, a time studied work route has revealed considerable unnecessary work and travel time which, when eliminated allowed a replanning of the duties of these personnel. Time studies of this type are also valuable in demonstrating the need for automatic and semi-automatic lubricating devices in frequent instances. The need for relocation of main oil storage facilities or the need of additional tank facilities with the objective of saving oiler time for other duties is frequently demonstrated.

In conclusion, a review of the great potential returns that are made possible by the installation of the combination occupation of oiler-inspector is considered. The caliber and qualifications of the personnel required are discussed and the part management must play in the success of the undertaking is reviewed.

AN IMPROVED METHOD FOR MOUNTING BEARINGS AND COUPLINGS

By A. STEWART MURRAY, SKF Industries, Inc.

▲ THE difficulty of disassembling large bearings and couplings has often prevented them from being mounted on their shaft seats with the theoretically desirable degree of interference. The ensuing compromise, employing lighter fits, often results in substantial maintenance and replacement expense because of the deterioration of the parts from the working that occurs under the strain of operating conditions.

The oil injection method devised by the writer's company permits heavy interference between large parts, because it is a simple and rapid practical method of both assembling and disassembling. In specific cases it permits the elimination of features, such as keys in couplings, when they are present because no other alternative is available.

Mathematical formulae permit calculation of the required hydraulic pressures, and determination of the condition of various members for the desired interference. Both small and large units have been tested in laboratories and commercial installations, and they

have demonstrated the effectiveness of this injection method.

A discussion of some of these units indicates the various important details and the solutions of the requirements of specific applications.

SOAKING PIT OPERATION

By H. V. FLAGG, American Rolling Mill Company

▲ ADEQUATE soaking pit capacity and performance are a matter of prime importance in all steel mill operations, especially in hot strip mills, where production and quality are dependent on slabs of uniform analysis and structure. This has been especially true at Middletown, where no break exists between the slabbing mill and the hot strip mill and slabs are taken directly from the slabbing mill to the hot strip mill after a nominal reheating in short slab furnaces which at best can serve only to replace the heat lost at the slabbing mill and over the transfer tables. Any shortcomings of the soaking pits under these conditions are bound to be reflected in loss of production or quality on the hot strip mill.

Regularity of strip mill operation is dependent upon a study supply of uniformly heated slabs. Since no open hearth shop has ever yet been able to develop a practice which can guarantee that furnaces will be tapped on a definite schedule, it is obvious that regular strip mill schedules cannot be established unless a slab reservoir is established to take heats from the open hearth as they come, and to provide the mill with properly heated slabs as needed. Generous soaking pit capacity is required to provide such a reservoir.

Soaking pit capacity existing at the time the hot strip mill was built consisted of six rows of four holes each 5 ft 6 in. × 10 ft 6 in. in size, old style, double checker, cross-regenerative pits, which were subsequently lengthened to 12 ft 0 in. in order to handle the larger slabbing ingots. Since that time, four rows of four pits each have been added, two rows being 6 ft 6 in. × 18 ft 6 in. and the other two 6 ft 6 in. × 23 ft 6 in. in size. From a charge capacity of ninety-six 57 in. ingots in the original twenty-four pits, the added pits have brought the total charge capacity up to 208 ingots, or more than double the original capacity.

Nominal heating time for hot ingots is 3½ hours and for cold steel is 9½ hours. Average ingot weight is 7.75 tons. On the basis of nominal required heating time and 30 per cent cold steel, total required ingot pit heating hours per month would be 65,700. Actual provided ingot pit hours, allowing one row out of service for repairs, totals to 122,000 per month, which indicates actual pit use of only 54 per cent or idle pit time of 46 per cent. The idle time figure reflects the amount of capacity provided to serve as the reservoir between the open hearth and the hot strip mill.

Fuel consumption for this type of operation totals 1.275 million Btu per ton, on the basis of net or lower heating values of 142,000 Btu for fuel oil, 950 Btu for natural gas, and 490 Btu for coke oven gas. This fuel value includes all warmup, holding, and operating fuel. Average fuel for the year 1946 with one less row of pits was 1.227 million Btu and for the year 1944 with still one less row was 1.118 million Btu. These figures indicate the added fuel consumption consequent to the increase in idle pit time. Compared to the average mill production in the year 1944, a monthly production increase of 11,600 tons has been made possible by the increased soaking pit capacity. The fact that fuel consumption increase has been held to a relatively low figure indicates that the fuel performance of the new pits has been very good.

Choice of the type of pit to be adopted was largely a matter of expediency. The largest possible amount of capacity was required from the limited amount of space available. Due to the nature of mill orders, large pits were undesirable and a limitation of eight 57 in. ingots to a pit charge was set. Adaptability to automatic control was important. The one-way fired rectangular pit seemed to fit the problem best and all of our additions have been of this type.

The experience with controls on these four rows of pits makes an interesting story. Several interrelated factors are involved, any one of which, if ignored or compromised, may militate against the success of the installation. With four holes built into one block, each hole must be treated as a separate entity and the control organized to operate it as a separate furnace. The control must be sensitive, fast, and positive. Relations once established must be held closely. Adequate draft must be available to draw the full fuel input under all conditions of charge. Air preheat temperature must be held constant even though the level set may mean a sacrifice of waste heat recovery much of the time. Adequate individual pit dampers must be provided, and this is a problem that has not yet been satisfactorily solved. Given a comprehensive treatment of all these considerations, it is possible to establish a heating system which will modulate the heat input truly to the demands of the charge, heat fast and evenly with reasonable fuel consumption, eliminate all washing of ingots, and make possible long furnace life.

MULTIPLE FUEL BURNERS FOR OPEN HEARTH FURNACES

By J. M. BRASHEAR, Inland Steel Company, East Chicago, Indiana

▲ MANY factors are operative in an open hearth furnace which affect the burners. Some of the subsidiary factors, not entirely independent of each other, worthy of consideration are: furnace pressure, draft, radiation from the walls and bath, preheated air temperature, fuel-air ratio, steam-oil ratio, degree of atomization, and the effect of flames on the refractories.

The burner equipment used on most furnaces is crude and shows little development from an engineering standpoint to that used many years ago. Probably the reason for this is the many complex and varied problems presented in open hearth furnace work.

The relation of burner and flame control to quality of product and fuel consumption is quite definite. It should be borne in mind that operating temperature is not a direct function of heat input but rather a function of heat input and the heat requirements of the furnace and work.

The rate of heat transfer is complicated by the size and shape of the furnace and the work. Of all the factors

involved in the design of burner equipment, there is probably none about which is less positively known than the limiting figures of heat which can be liberated per cubic foot of combustion space. The practice of installing oversized burners so as to be certain of the heating capacity may therefore be carried to an extreme.

Efforts have been made to correlate ignition velocities, heating values and the maximum heat delivery capacity for given combustion volumes. It is not known whether the maximum heat delivery occurs coincident with mixtures having maximum ignition velocities.

The multiple burner described in the discussion, and currently in use in our shops, was developed during the past six years to reduce or eliminate some of the troubles caused by these variables.

The burner equipment described has made it possible to also study many of the subsidiary factors associated with the heat delivery and maintenance of atmosphere in the furnace.

The primary benefits derived from its use are: a burner which can be readily adjusted to suit melting conditions in the furnace; can be adjusted to compensate for furnace wear, which reduces materially the restriction in the throat and uptake areas by elimination of the "doghouse" construction normally used with stationary type burners of the so called "dry" type; and which, since it is supported on the furnace binding independent of the refractories, lends itself readily to maintenance and repair.

The burner is adaptable to and is currently being used on all the types of fuel described in the discussion. Comparative data on fuel consumption, production and refractory consumption for the past three years, pictures and drawings of the burner and burner mounting will be shown.

DESIGN AND PERFORMANCE OF A REFRACTORY RECUPERATOR

By E. G. SMITH, Amsler-Morton Corporation, Pittsburgh, Pennsylvania

▲ THE recuperative method of preheating combustion air is relatively old, but in spite of the fact that its use permitted some very desirable improvements in furnace design and heating practice, the recuperator was not generally accepted in industry until the past decade. This failure of a desirable piece of equipment to establish itself can be attributed to faulty recuperator design and, therefore, it could not achieve the potential economies that accrue through the use of high preheat temperatures.

The vertical tube refractory recuperator is accepted by industry today because certain fundamental problems were recognized and overcome in the course of its development. First, the materials had to be of low porosity and capable of withstanding practically the same temperatures that exist in the furnace without reacting with substances that are often carried in the furnace gases. Second, the construction had to be such that the structure could expand and contract without stressing the elements or opening the joints. Third, the heat exchange surfaces had to be self-cleaning to prevent the formation of deposits that would retard heat flow. Fourth, the design had to lend itself to installation in close relationship to the furnace in order to minimize heat losses.

The solution of these problems permitted the development of a recuperator that could receive waste gases directly from the exit ports of the furnace and deliver air to the burners at temperatures ranging from 1300 to 1950 F depending on the kind of fuel being burned. This recuperator has been applied to various types of furnaces but always in a relationship that is characterized by certain distinctive features made possible by the selection of correct materials and logical design. First, the recuperator and furnace are integrated to form a self-contained unit which includes the waste gas flues, hot air flues and burners within the principal structure. Second, the burner consists of a simple refractory port block, properly calibrated, and a pipe for introducing fuel into the hot air stream. Third, the air is pumped into the recuperator by a low pressure fan and is metered and controlled at room temperature.

This design of furnace now stands out as a basic type in the industry and results from the recognition of fundamental problems and the application of simple natural laws to accomplish their solution. The records established during the past decade by the vertical tube refractory recuperator in fuel economy, increased production, and low maintenance costs have securely established this recuperator in the steel industry and have proven that it will add to the efficiency of any industrial heating or melting process.

LUBRICATION OF ROLLING MILLS

By L. E. LOVITT, Socony-Vacuum Oil Company

▲ LUBRICATION has played a most important part in the development of the modern rolling mill which can be recognized by the changes made in the methods of applying lubricant to reduction gears, pinions and grease lubricated bearing surfaces. The open gears driving mills of older design have been totally enclosed, and lubrication is accomplished by means of specially designed circulation systems. Pressure grease systems have replaced the manual methods of grease application to the many points on the rolling mill requiring that type of lubricant. The introduction of the oil-film type of bearings was only possible because of positive lubrication. Correct lubrication is a major factor in minimizing maintenance. Consequently, maintenance work should be analyzed and correlated with lubrication.

The author points out that before a proper lubricant can be selected it is necessary to understand how its service is affected by such operating factors as loading, speed, temperature, contamination, and consumption. The primary purpose of lubrication is to reduce friction between moving parts. This permits continuous operation and reduces wear. In reducing friction, metallic friction is replaced by fluid friction. As speeds increase, the viscosity of the oil has a decided influence on the operating temperature of the lubricant. In circulation oiling systems, the oil serves the dual purpose of a lubricant and a fluid medium for carrying away heat.

It is seldom that complete lubrication failure occurs. Such a condition would manifest itself in a very short

time. Usually bearing temperature would increase beyond a safe value in a matter of minutes, followed by equipment failure. Partial lubrication failure is usually the problem encountered. Very often troubles described as lubrication failures have started several months ahead of the actual mechanical failures. In many cases, the condition of the lubricant as observed over a period of time, particularly during the first few months of operation, will indicate whether satisfactory lubrication is being secured.

Separate circulation systems are required for motor generator sets, and large driving motor bearings, reduction gears, pinion stands, oil film bearings, and screw down drives which are the principal parts of a rolling mill. The lubrication problems involved in these separate systems vary considerably. Their solution requires an intelligent interpretation of the changes that occur in lubricant characteristics, and how those changes are influenced by operational factors.

Grease as a lubricant does not carry away heat and bearing temperatures are usually higher. In some few applications, the excess grease forced from the bearing acts as a partial seal against outside contamination. Such sealing is neither positive nor reliable and attention to mechanical seals is necessary.

Contamination is an important factor in determining whether the lubricant can be continued in service. Procedures for removing contamination are discussed as well as how to determine when a contaminated lubricant should be taken out of service.

ROLLING AND TESTING LUBRICANTS FOR LIGHT GAGE SHEET

By R. J. NEKERVIS and R. M. EVANS, Battelle Memorial Institute

▲ This paper covers the experimental development of mineral-base rolling lubricants to replace palm oil in the cold reduction of steel to tin plate gages, and methods of predicting performance in commercial practice. Final selection of the lubricant has not been made as yet, pending the results of confirmatory commercial tests. The basis for selection is a study of the effect of the following chemical factors on rolling lubricant performance:

1. Effect of chain length and configuration of saturated and unsaturated hydrocarbons from petroleum.
2. Effect of fatty acids: effect of degree of saturation, chain length, and configuration.
3. Effect of esters, glycerides, and soaps.
4. Effect of alcohols.
5. Effect of film strength, detergent, antiwear, and oiliness agents.
6. Effect of synthetic proprietary compounds.

Physical characteristics of these materials on rolling were also considered.

In evaluating the chemical factors, the following properties were considered to be of paramount importance:

1. Greater friction reduction if it could be obtained without the risk of roll slippage. Stability, uniform spreading, and adherence of the lubricant under conditions of commercial practice are corollary requirements.
2. Easy removal after rolling. Removal by vaporization during annealing was the first objective. Easy cleaning in existing equipment was second.
3. Attainment of satisfactory lustre.

Evaluations of the various factors was accomplished by means of screening tests. The test for lubricating properties was essentially a measurement of the friction coefficient on a laboratory cold-rolling mill with all rolling variables except reduction in thickness and pressure, either held constant, or varied, at equal rates and amounts.

The mill upon which these tests were run was a 50-horsepower, two high, combination hot and cold mill with forged steel, 8-inch diameter by 12 inches, cold rolls mounted in plain bronze bearings. Pressures were measured by means of a capsule-type pressure gage placed between the bearing chock and screw-down on one of the housing posts. Rimmed steel sheets of uniform grade, temper, hardness, and dimensions were used as test specimens. The usual assumptions, constant uniform vertical pressure, plane vertical sections remaining plane, constant-friction coefficient, and constant rate and amount of work hardening during reduction, were used in this work. Roll flattening, however, was taken into account. A simple method of measuring the friction-reducing properties of a lubricant without tedious calculation was evolved. The effects of speed, temperature, pressure, quantity of lubricant, and hardness of the test plate on the relative ratings were taken into account.

Palm oil was used as a comparison standard. The effects of the palm oil constituents and of possible impurities and contaminants (e.g., soaps) were determined as part of the program to determine the effects of the various chemical factors. Reasons for discrepancies between the first confirmatory commercial test and the laboratory findings are explained, and the modification made as a result of this confirmatory test is discussed.

Screening tests for the rating of lustre, ease of application, ease of cleaning, and strength of attachment under high-pressure water sprays are also described, and the cause of poor lustre and its relationship with wear are discussed.

OXYGEN IN THE STEEL INDUSTRY

By H. W. McQUAID and F. E. PAVLIS, Air Products, Inc.

▲ THIS paper discusses the developments in the production of oxygen which now make it available at a reduced cost when generated at the place of use, and also discusses the effect of the availability of this lower cost oxygen on the steel industry.

The generation of oxygen for use in the steel industry divides itself into two types. One is the high purity (99.5 per cent) which requires special equipment to remove practically all of argon and nitrogen from the oxygen. The other is the lower purity type (80 to 95 per cent) which requires simpler equipment and because of the usual much larger capacity are more economical of power and labor. The lower purity type is usually made to supply oxygen only at low pressures and hence costly compressing equipment is eliminated unless the

oxygen is needed at pressures much above atmospheric.

It is pointed out that equipment is now being built over a wide range of capacity for the production of high purity oxygen at lower costs than is possible when it is transported in cylinders either as a liquid or a gas.

It is indicated that this lower cost oxygen is especially adapted to expanding the many uses to which high purity oxygen is now put in the steel industry. Some of these uses would be surface conditioning by scarfing, scrap preparation and general maintenance uses. It is also especially adapted to the direct melting of hot scrap in the open hearth and electric furnace as well to carbon reduction. Here the economies are important, especially to the small open hearth and electric furnace operator. In the correct sizes of these high purity oxygen generators the cost of oxygen is low enough to make it of interest for all such operations and even for blast enrichment on small open hearths.

The production of tonnage lower purity oxygen for blast furnace and open hearth blast enrichment is still to be demonstrated although two large plants of this type are being constructed.

THE USE OF OXYGEN IN THE OPEN HEARTH

By E. C. McDONALD, Republic Steel Corporation

▲ THIS paper describes the experience of making 726 heats in two 200-ton furnaces in the Cleveland district of the Republic Steel Corporation between December 9, 1946, and August 18, 1947, using a combination of oxygen through the burners, and direct injection into the bath by means of a submerged pipe or lance. The normal charge contains 70 to 80 per cent hot metal.

Burner oxygen in the range of 30,000 to 40,000 cubic feet per hour was used after the scrap was charged on heats up to May first. After that date burner oxygen was not used until the doors were banked in order to conserve oxygen. The predominant fuel is oil but some coke gas was used. The use of oxygen in the burners permitted an increase in fuel rate while melting down by fifteen million Btu per hour to a maximum of ninety-five million Btu per hour.

Usually the lancing operation was started shortly after the first flush and the starting time was governed by experience experimentally acquired. Occasionally when conditions were favorable, the lancing operation was started directly after the addition of hot metal.

The normal rate for lancing use was 50,000 cubic feet per hour but flows up to 100,000 have been used by employing two lances. Fuel is greatly reduced or shut off during the lancing periods. Burner oxygen was used as required to quickly restore and maintain temperature as fuel is turned on between lances. Oxygen consumption has ranged between 850 and 1300 cubic feet per ton divided about equally between burner use and lances.

Five to six lances were used per heat with a life that averaged about twenty minutes. Occasionally a lance would last up to one hour when conditions were favorable and floor traffic did not require a withdrawal. Total time per heat the lances were in the furnaces averaged two hours with a range of from one and one-half to three hours. Standard one inch pipe, twenty feet long, was the predominant size.

Furnace design changes made to improve refractory life included raising the roof, opening up the ends, increasing the size of uptakes and water cooling the back walls. No appreciable increase in roof life resulted from these changes. Checker openings were increased to reduce blocking from the dust carried over while using lances.

It has been proven that heat time can be reduced up to 40 per cent and fuel consumption decreased 30 per cent by the use of oxygen; but monthly production rates have not been that impressive due to the amount of time the furnaces were out of service for brick work which was largely roof failure from splash and iron oxide penetration. Overcoming these difficulties constitutes the number one problem being pursued at present.

Next to refractories the emission of dust while using the oxygen lances was the most series problem. After experimenting with a pilot plant, both furnaces were equipped with 85 per cent efficient waste gas scrubbers located after the waste heat boilers to reduce the dust escaping into the atmosphere, but better dust collection will be required and is to be installed. Further experiments with a pilot plant showed we could get 95 to 98 per cent removal with a water flooded venturi tube located before and in conjunction with the existing scrubbers. These improvements are to be made and at the same time the existing fans will be replaced with larger ones to be located after the scrubbers.

Research done on the red to chocolate fume emitted while lancing with oxygen showed it to be highly magnetic and roughly 88 per cent ferric oxide. Under the electron microscope the mean particle size was found to range between 0.115 to 0.183 microns. During lancing, dust content of the waste gas entering the washer ranged between one and six grains per cubic foot corrected to 60 F, the highest dust content being from the first lances used on each heat. Dust testing was done with a capsule weighed before and after sampling and on a metered quantity of flue gas similar to a dust determination on blast furnace gas.

Quality, yield and surface on the oxygen heats has equalled regular practice. As this work is still considered experimental the economic aspect is not discussed. The continuation and especially an extension of the use of oxygen as described in the paper is dependent upon a number of conditions:

1. The production of oxygen at an economical rate.
2. The development of equipment and methods that will permit an application in the bath without so much destructive effect on refractories.
3. Development of better refractories.
4. A means of overcoming the nuisance of the fume at a lower cost.

Neloy flame hardened industrial Gears and Track wheels

Note the discoloration on the flame-hardened surfaces of the gears shown above . . . An unretouched photograph.

YOU have at your command, when you do business with National-Erie, a wide range of gear cutting equipment for the production of spur, bevel, mitre, Sykes continuous Herringbone gears . . . The complete facilities of modern machine shops manned by expert machinists . . . Moreover, you have heat-treating facilities for fully quenched gears, which together with electric and open-hearth furnace foundry facilities, permit complete control of the manufacture of the materials you order . . . As you note above, a typical group of diversified industrial Neloy gears and crane track wheels for Neloy Flame Hardening treatments No. 10A and No. 10B . . . Whether you need machine tool gears of flame hardened Neloy or Neloy Molybdenum Steel, or other industrial gears made to your specifications, symbolizes throughout the heavy industries, the outstanding source of supply.

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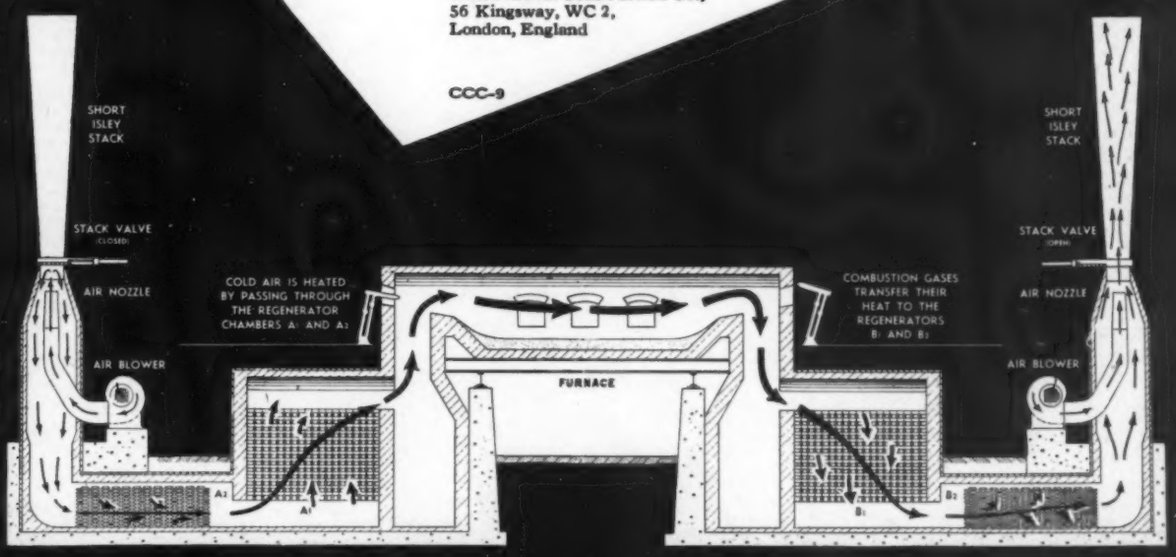
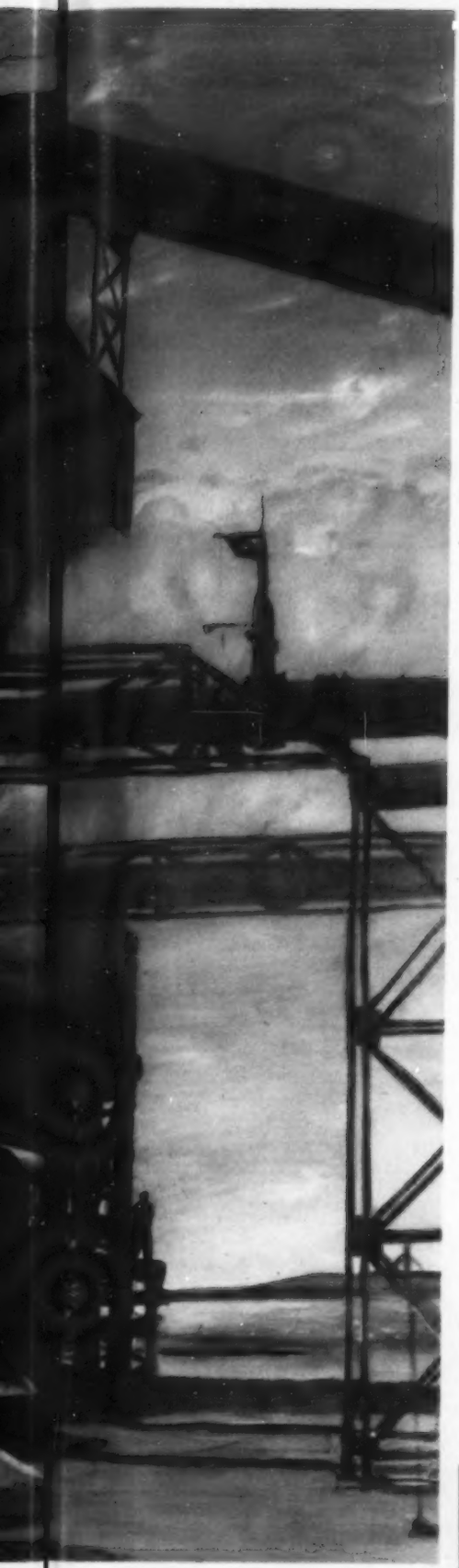

SHORT ISLEY STACK
STACK VALVE (CLOSED)
AIR NOZZLE
AIR BLOWER
COLD AIR IS HEATED BY PASSING THROUGH THE REGENERATOR CHAMBERS A1 AND A2
FURNACE
COMBUSTION GASES TRANSFER THEIR HEAT TO THE REGENERATORS B1 AND B2
SHORT ISLEY STACK
STACK VALVE (OPEN)
AIR NOZZLE
AIR BLOWER

ISLEY FURNACE CONTROL SYSTEM



6 reasons

WHY YOUR COKE OVEN PLANT SHOULD BE BUILT BY KOPPERS

Koppers-Becker Low-Differential Coke Ovens with Waste-Gas Recirculation are the most advanced ovens available and they have these advantages:

1. They make the best possible grades of domestic and metallurgical coke from suitable coals under widely-varying conditions with the least underfiring requirements, and the highest yields of byproducts.

2. They can be built (without interference with the uniformity of heating) in oven capacities up to 20 net tons of coal per oven charge, in small or large batteries, to suit local conditions.

3. They can be underfired efficiently with coke-oven gas, natural gas, blue gas, carburetted water-gas, propane, butane, high-B.t.u. refinery gas, producer gas or blast-furnace gas, producing uniformly heated coke over a wide range of coking times.

4. They are built of the best materials available and of sturdiest design; are free from complications; are simple to control, and accessible throughout, insuring low maintenance cost and long life.

5. They can be operated at high speed with greater safety and at lower flue-temperatures because of the action of the waste-gas recirculation system.

6. By means of a separate and efficient blast-furnace-gas-enriching system, they can be operated to produce as much coke when underfired with low-B.t.u. blast-furnace gas as when underfired with coke-oven gas with the least requirement of high-B.t.u. coke-oven gas for enriching.

K
KOPPERS

Koppers engineers will be glad to work with you on your plans for coke oven plants, light oil plants, by-product plants, gas-purification systems, gas producers, precipitators and any other equipment or apparatus connected with coal carbonization.

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● Need tool steel? Midvale tool steel bars carried in wide assortment —all common grades and shapes warehouse-stocked—and ready for one-day shipment. Midvale's tool steel stocks include the Carbon, Oil Hardening, High Speed, Shock Resisting and Special Alloy Grades. Ask for Midvale's stock list. Gives you regular information about Midvale tool steels.

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ANNUAL CONVENTION

ASSOCIATION OF IRON AND STEEL ENGINEERS

WILLIAM PENN HOTEL, PITTSBURGH, PENNSYLVANIA

SEPTEMBER 22, 23, 24, 25, 1947

OFFICIAL *Program* ... WILLIAM PENN HOTEL

17th FLOOR

Monday, September 22

9:00 a.m. — REGISTRATION — Silver Room

9:00 a.m.—LADIES' REGISTRATION—Parlors E and F

9:15 a.m. — BUSINESS MEETING — Urban Room
Conducted by President L. R. Milburn

9:30 a.m. — ELECTRICAL SESSION — Urban Room
Chairmen:
I. N. Tull, Republic Steel Corporation
J. J. Booth, Carnegie-Illinois Steel Corporation

"Twin Motor Drives for Tandem Cold Strip Mills," by R. H. Wright, Westinghouse Electric Corporation.

"Operation and Maintenance of Variable Voltage Control Systems," by A. D. Howry, Alan Wood Steel Company.

"Improved Reversing Mill D-C Generators," by C. Lynn, Westinghouse Electric Corporation and Walter H. Burr, Lukens Steel Company.

2:00 p.m. — ROLLING MILL SESSION — Urban Room
Chairmen:
A. G. Ericson, Carnegie-Illinois Steel Corporation
C. W. Barrett, Republic Steel Corporation

"The Y-Mill — A New Type of Cold Strip Mill," by A. B. Montgomery and W. M. McConnell, Mackintosh-Hemphill Company.

"Factors in the Operation of a Mannesmann Piercing Mill," by H. R. McLaren, Timken Roller Bearing Company.

"Applications of the Basic Principle of Rolling in Roll Design," by Ross E. Beynon, Carnegie-Illinois Steel Corporation.

2:00 p.m. — OPERATING PRACTICE SESSION — Cardinal Room

Chairmen:
J. H. Vohr, Carnegie-Illinois Steel Corporation
R. P. Tooke, American Rolling Mill Company

"Job Evaluation," by L. H. Brown, Wheeling Steel Corporation.

"New Techniques in Conditioning Stainless Steel," by A. E. Hamilton, Jr., Hamilton Pump Company, Inc.

"The Powder Process in Stainless Steel Production," by C. J. Burch and E. M. Holub, The Linde Air Products Company.

Tuesday, September 23

9:00 a.m. — COMBUSTION SESSION — Cardinal Room

Chairmen:
C. J. Wyrough, Jones and Laughlin Steel Corporation
C. E. Duffy, Bethlehem Steel Company

"Uses of Oxygen in Steel Production," by J. H. Zimmerman, The Linde Air Products Company.

"The Use of Oxygen in the Open Hearth," by E. C. McDonald, Republic Steel Corporation.

"Agitation of the Open Hearth Bath with Oxygen and Compressed Air," by J. N. Hornak, Carnegie-Illinois Steel Corporation.

9:00 a.m. — STANDARDIZATION SESSION — Urban Room

Chairmen:
F. W. Cramer, Carnegie-Illinois Steel Corporation
V. E. Schlossberg, Inland Steel Company

Standardization Committee Report — F. W. Cramer, Chairman, AISE Standardization Committee.

Final Report of D-C Mill Motor Committee.— F. O. Schnure, F. A. Compton, Jr., C. B. Hathaway, and I. C. Smith.

Reports on Operational Experience with New D-C Mill Motor. — John W. Deimler.

Effect of Proposed New AISE Mill Motors on Motor Brake Design. — A. H. Miles, J. A. Cortelli.

Report of Committee on Standardization of Safety Switches. — Eric Anderson.

Report of Committee on Standards for Surface Finish. — H. B. Conover.

12:15 p.m. — OLD TIMERS LUNCHEON — Forum Room

2:00 p.m. — COMBUSTION SESSION — Cardinal Room

Chairmen:
C. W. Bruce, Republic Steel Corporation
B. B. Bargman, Carnegie-Illinois Steel Corporation

"Oxygen in the Steel Industry," by Harry W. McQuaid and F. E. Pavlis, Air Products, Inc.

"Steam Generation and Maintenance of Power Stations for Steel Plants," by John J. Alexander, Republic Steel Corporation.

"Modern Design of Multiple Fuel Steam Units," by A. R. Mumford, Combustion Engineering Company, Inc.

2:00 p.m. — ELECTRICAL SESSION — Urban Room

Chairmen:
M. B. Antrim, Lukens Steel Company
D. C. Nelson, Jones and Laughlin Steel Corporation

"Electric Heating of Steel Strip for Continuous Processing," by A. R. Ryan and F. E. Ackley, General Electric Company.

"Trends in Lifting Magnet Design and Application," by John D. Leitch, The Electric Controller and Manufacturing Company.

"Fibrous Glass Electrical Insulating Materials," by Harry O. Collis, Owens-Corning Fiberglas Corporation.

Wednesday, September 24

9:00 a.m. — INSPECTION TRIP — New Facilities at Homestead Works, Carnegie-Illinois Steel Corporation

2:00 p.m. — LUBRICATION SESSION — Cardinal Room

Chairmen:
C. R. Hand, Bethlehem Steel Company
D. N. Evans, Inland Steel Company

"Industrial Uses of Synthetic Lubricants," by W. H. Millett, Carbide and Carbon Chemicals Corporation.

"Rolling and Testing Lubricants for Light Gage Steel," by R. J. Nekervis and R. M. Evans, Battelle Memorial Institute.

"Barium Lubricating Grease," by C. J. Boner, and G. W. Miller, Battenfeld Grease and Oil Corporation.

2:00 p.m. — STANDARDIZATION SESSION — Urban Room

Chairmen:
F. W. Cramer, Carnegie-Illinois Steel Corporation
E. L. Anderson, Bethlehem Steel Company

"Proposed New Crane Specifications," by I. E. Madsen, Association of Iron and Steel Engineers.

"Report on Crane Bridge Drive Specifications," by Marc de Ferranti, General Electric Company.

"Research Report on Design of Crane Ladle Hooks," by Professor C. W. Muhlenbruch, Carnegie Institute of Technology.

"Research Report on Design of Hot Metal Ladles," by K. Knudsen, W. Munse and B. Johnston, Fritz Engineering Laboratory, Lehigh University.

Report of AISE Sling and Crane Chains Standards Committee. — J. B. Mitchell, and J. F. Byers.

7:30 p.m. — Formal Dinner-Dance — Ball Room

Speaker: C. R. Cox, President, Carnegie-Illinois Steel Corporation.

Thursday, September 25

9:00 a.m. — MECHANICAL SESSION — Urban Room

Chairmen:
H. W. Neblett, Inland Steel Company
T. R. Moxley, Wheeling Steel Corporation

"Metals in Service," by P. M. Hess, Safe Harbor Water Power Corporation.

"Principles of Job Scheduling in a Machine Shop," by L. E. Fuller, Jr., Carnegie-Illinois Steel Corporation.

"Prevention of Some Mechanical Failures in Steel Plant Equipment," by O. J. Horger and Gordon A. Stumpf, Timken Roller Bearing Company.

9:00 a.m. — OPERATING PRACTICE SESSION — Cardinal Room

Chairmen:
C. P. Betz, Hanna Furnace Division, Great Lakes Steel Corporation
J. L. Tatman, Wheeling Steel Corporation

"Preparation of Coal for Coke Production," by Preston E. Jordan, Wheeling Steel Corporation.

"Coke Oven Machinery," by Ragnar Berg, Koppers Company, Inc.

"Progress of High Top Pressure Operation of the Pig Iron Blast Furnaces," by B. S. Old, E. L. Pepper and E. R. Poor, Arthur D. Little Company.

2:00 p.m. — LUBRICATION SESSION — Cardinal Room

Chairmen:
C. E. Pritchard, Republic Steel Corporation
R. S. Shoemaker, American Rolling Mill Company

"Lubrication of Rolling Mills," by L. E. Lovitt, Socony-Vacuum Oil Company.

"Some Aspects of Lubrication Equipment Maintenance," by Robert A. Kraus, Republic Steel Corporation.

"An Improved Method for Mounting Bearings and Couplings," by A. Stewart Murray, SKF Industries, Inc.

2:00 p.m. — COMBUSTION SESSION — Urban Room

Chairmen:
H. S. Hall, Lukens Steel Company
C. M. Yaeger, Jones and Laughlin Steel Corporation

"Soaking Pit Operation," by H. V. Flagg, American Rolling Mill Company.

"Multiple Fuel Burners for Open Hearth Furnaces," by J. M. Brashear, Inland Steel Company.

"Design and Performance of a Refractory Recuperator," by E. G. Smith, Amsler Morton Corporation.

A Welcome to Steel Mill Operators and Engineers

Forty years ago the capacity of the U. S. iron and steel industry was 38,000,000 net tons. Today it is 2½ times as large — 91,241,230 net tons. This growth has gone hand in hand with the growth of the Association of Iron and Steel Engineers which was founded forty years ago. We believe we are justified in claiming a share of this increase in capacity as well as an increase in the efficiency of operation. The advancement of the technical and engineering phases of the production and processing of iron and steel has been the consistent purpose of the AISE. Through the medium of meetings such as the AISE annual convention, we have exchanged ideas to our mutual benefit.

The officers, directors and staff of the Association gave careful thought to the program for the fortieth year. Each engineering division is represented on the convention program with selected authors and subjects. We firmly believe that you cannot fail to take home from this convention many good ideas that you will use in your plant to the advantage of both your company and yourself.

As is our custom, we extend a cordial welcome to all operators and engineers of the iron and steel industry in meeting with us for the interchange of our ideas for the advancement of the industry.

L. R. MILBURN

President, AISE

SERVICE TO STEEL MILLS by LINK-BELT

Complete line of Chains for transfer tables, coil conveyors, furnace conveyors, feeder and catcher tables, sheet pilers, draw bench and other equipment . . . Elevators and Conveyors of all types, such as belt, bucket, screw, flight, Bulk-Flo, drag chain, apron, Sidekar-Karrier, trolley, Oscillating-Trough, etc. . . . Vibrating Screens . . . Dryers and Coolers . . . Skip Hoists . . . Car Dumpers . . Car Spotters and Haulage Systems . . . Portable Conveyors and Bucket Loaders . . . Traveling Water-Intake Screens . . . Automatic Stokers . . . Silent and Roller Chain Drives . . . Speed Reducers and Increasers . . . Variable Speed Transmissions . . . Sprockets . . . Gears . . . Clutches . . . Couplings . . . Babbitted, Ball and Roller Bearings, etc.

LINK-BELT CONVEYORS MOVE coils smoothly . . .

Link-Belt conveyors are especially designed to move and transfer coils smoothly — and without edge damage. While built in a variety of designs for specific production problems — the basic thought in ALL designs is the reduction of scrap losses due to strip damage.

Ample bearing surfaces carry the coils smoothly — without telescoping. Rugged construction, conforming to steel mill requirements, eliminates delay and allows low operating costs.

Mill equipment by Link-Belt means a complete Link-Belt service... design, manufacture and installation. As pioneers in the development of materials handling in the steel industry, you can look to Link-Belt for practical, proven cost-reducing mechanization.

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Chicago 9, Pittsburgh 19, Cleveland 13, Detroit 4, Indianapolis 6, St. Louis 1, Kansas City 6, Mo., Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

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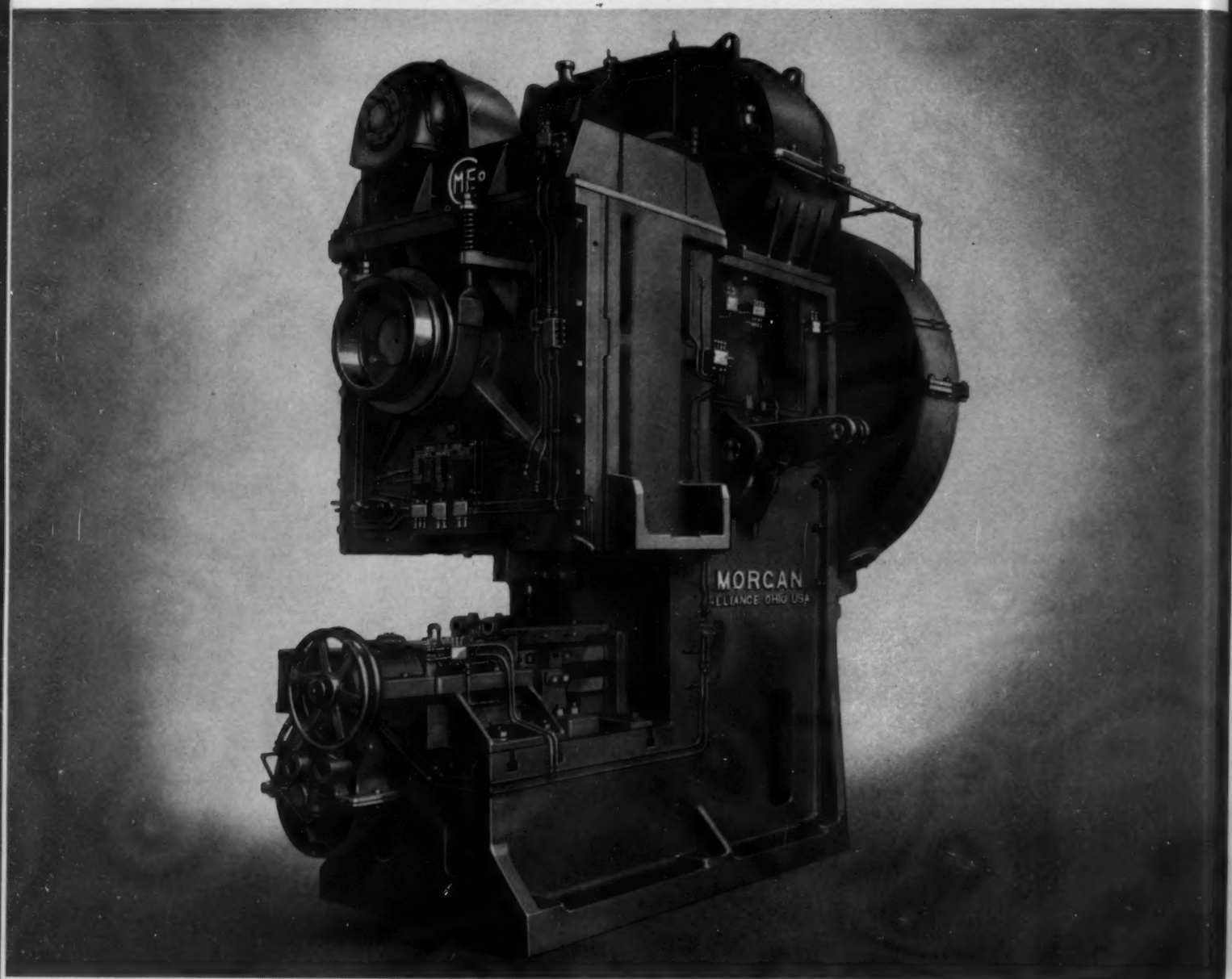
PREPARATION EQUIPMENT . . . POWER TRANSMISSION MACHINERY

BUILT BY MORGAN Engineering

MORGAN 600-TON MOTOR DRIVEN STRUCTURAL SHEAR



Illustrated is a Morgan 600-Ton Motor Driven Structural Shear for shearing products from a Morgan 29″ and 23″ Rail and Structural Mill. It will shear up to 4½″ x 4½″ Billets and 4½″ Rounds; Eye Beams and Channels up to 15″; a full line of Angles with equal and unequal legs up to 8″ x 8″; also Fish and Tie Plates.

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NEWS SUPPLEMENT SEPTEMBER, 1947

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Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

HOT MILL COMPLETES TWELVE YEARS WITHOUT A SINGLE LOST TIME ACCIDENT

▲ The hot mill department at Wood works of U. S. Steel's Carnegie-Illinois Steel Corporation has completed 12 consecutive years without a single lost time accident, general superintendent Carl M. Nystrom announced.

One of the country's few remaining hand mills, Wood works' hot mill rolls stainless steel sheets for such varied users as Swiss watchmakers, Chicago surgical instrument manufacturers and California wine cask manufacturers. Individual orders are usually small, calling for sheets of many different sizes — and a great deal of rolling skill. The hot mill men at Wood works have that skill in abundance, borne of long experience. It seems that skill and safety go together.

Comment at Wood works divided credit for the record between Carnegie-Illinois' safety program and skill of Wood works' hot mill rollers.

Foreman Hays Irvine, who has been at Wood works since 1904, attributed the hot mill safety achievements to "safety huddles" called frequently to caution workmen in safe practices. "On the job" safety training under the Carnegie-Illinois safety program, also counted heavily, according to Mr. Irvine.

"Safety is just as much a part of our job as rolling stainless steel sheets," said 35-year veteran George Keddie. "All the workers are taught only one way of doing the job — the safe way."

"Better rolling" was the explanation of Charles Ulm, who has 45 years in the hot mill to back his judgment. Ulm also believes improved safety devices have made the job in the hot mill a lot safer in the last ten years.

All the way through the hot mill, reasons for the 12-year safety record varied with every worker. One point was unanimous, however. Nowhere in the mill could be detected any doubt that the perfect record would be standing indefinitely.

Credit for the safety record established at Wood works is divided between the company safety program and the cooperation of the men.

REPUBLIC TO BUILD PIPE MILL IN SOUTH

▲ Large diameter pipe is badly needed for pipe lines in this country and abroad. Accordingly, plans have been announced by Republic Steel Corporation for construction as soon as possible of a mill to produce this product. The mill will be built at Republic's steel plant in Gadsden, Alabama.

When completed the new mill will produce electric welded steel pipe in diameters from 20 to 30 in. and in lengths of 30 ft. The pipe will be made from flat steel plates rolled on Republic's Gadsden plate mill. This plate will be cold formed into tubular shapes and electrically welded.

The mill will be housed in two buildings to be built adjacent to the plate mill. The first of these will be 360 ft long and will extend from the end of the present plate mill shipping

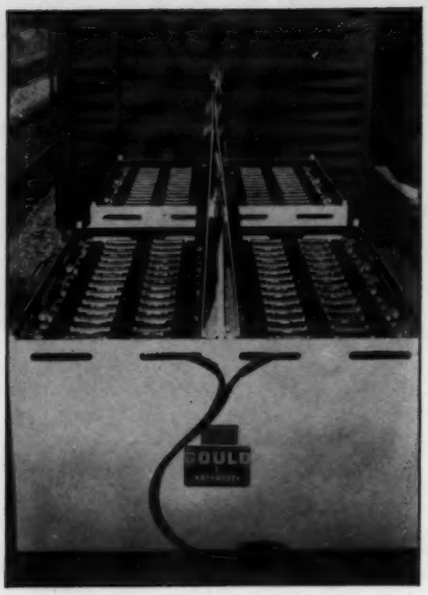
building. The second will run parallel to the first and will be 648 ft long. Each will be 113 ft wide and will be of the heavy duty factory type. Open air inspection and storage areas will also be added.

Engineering of the entire project is now well under way and every hope is held that the mill may be in operation by June 1948. It is likely that employment of 300 additional persons will result from placing the mill into operation.

INLAND STEEL BUYS SIX-TON BATTERIES

▲ Over six tons of storage battery in a single container. That's a lot of battery power, yet the completion of four of these giant batteries has just been announced by National Battery Company, Gould Storage Battery Corporation, a wholly owned subsidiary of National.

Never before in the history of the Gould company have batteries of this size been assembled. Each contains 30 cells type KRLD-31 plate units. The containers, made of heavy steel, are 41 in. high, 62¾ in. long, and 55⅜ in. wide. The batteries deliver 60 volts, and are rated at 1500 ampere hours at the 6-hour rate of discharge. They will be used by the Inland Steel Corporation to power large ram trucks, which are capable of handling 30 tons of steel at one time.



Completion was solved by final assembly on a railroad flat car.

As an interesting comparison, the power output of one of these batteries is equal to that of approximately 200 auto starting batteries connected as a single unit. By the same token, this battery would supply enough current to take care of the average house for 22 days without recharging.

The construction of these huge batteries presented an unusual handling problem for Gould. Their completion was solved by assembling the component parts on a flat car on a siding. Inland Steel, however, will find changing batteries on their ram trucks a simple matter. Each battery has a lifting hole centered in a ¾ in. steel bulkhead running lengthwise of the tray. With this arrangement the removal and replacement of a battery is comparatively easy when cranes of adequate capacity are available.

THOMAS STEEL BUILDS WATER FILTRATION PLANT

▲ A contract for the construction of a water filtration plant for the Thomas Steel Company, Warren, Ohio, has been awarded to F. H. McGraw and Company. The contract calls for the structural design, layout, and construction of a plant consisting of a three-story filtration building, pump house, and river intake. More than a mile of cast iron pipe will be used in the construction.

ACID AND ALKALI-PROOF CEMENT NOW AVAILABLE

▲ Acid-proof and alkali-proof cements of both silicate and resin types for bonding acid-proof brick and tile have been manufactured by the Pennsylvania Salt Manufacturing Company for fourteen years. The principal uses of these cements have been in chemical plants, oil refineries, steel mills, pulp and paper mills and allied industries.

Pennsalt plating room floors cement was developed early in the war as a bonding agent. It is resistant to most acids, alkalies and solvents. For that reason it has proved to be an

ADVANTAGES OF WING REVOLVING UNIT HEATERS

1. Makes workers feel comfortable, live and invigorated — more productive.
2. Reaches over and around obstructions and into out-of-the-way corners.
3. Moving discharge heats up plant quickly on cold mornings.
4. Reduces absenteeism due to colds resulting from drafts, chills or overheating.
5. Is an excellent cooling system in summer with steam off and fans on.

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UNIT HEATERS
insure complete
HEAT COVERAGE

NOT just another unit heater, the WING REVOLVING HEATER is unique in that it does what no other heater can do—its slowly revolving outlets gently distribute the heat continuously in a constantly changing direction. It reaches over, around and under obstructions and into out of the way corners. WING REVOLVING HEATERS are in many of the country's leading industrial plants.

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excellent material for use in floor, drain and man-hole construction where corrosive conditions may be alternately acid, alkali or solvent.

Initial installations of this material have been watched closely, and results, as well as information constantly passed along by Pennsalt laboratory technicians, support the manufacturer's conviction that Pennsalt PRF cement possesses unusual qualities in both chemical resistance and certain physical properties essential to good construction. A northeastern sulphite mill recently reported that it was the best bonding agent ever tried under acid and caustic conditions.

Essentially there is little difference between Pennsalt PRF cement and Pennsalt PRFK cement. The latter will set up in approximately one-half of the time required by regular grade Pennsalt PRF cement. This, of course, is more convenient for certain critical construction jobs, where not only the nature of the installation but also the emergency of the maintenance is important. Pennsalt PRFK cement resists the same corrosive conditions and has the same physical characteristics as the slower setting Pennsalt PRF cement.

This resin bonding agent is gaining popularity rapidly in large industrial plants. Plant personnel is becoming increasingly conscious of the need for lasting plant equipment; and sewers, floors and drainage systems are receiving considerable attention. In addition, certain states have enacted laws to compel treatment of industrial wastes before they are emptied into public streams. Both Pennsalt PRF cement and Pennsalt PRFK cement are designed to meet the exacting requirements of such important construction.

No corrosion-proof material can honestly be said to fill every need, and no such claims are made for Pennsalt PRF cement.

CRUCIBLE BUILDS COKE PLANT AT MIDLAND

▲ Crucible Steel Company of America has awarded Koppers Company, Inc., a contract for construction of new coke and by-product facilities at its Midland, Pennsylvania, plant at a price in excess of $6,000,000.

A battery of 63 coke ovens, coal

Lift ferrous metals this way

to keep handling costs down

MAGNETIC MATERIALS HANDLING is a *proved way* to offset higher hourly wage scales.

Ohio Magnets, for example, whisk strip steel coils from one plant area to another *without handling assistance on the floor.*

There is a specific Ohio Magnet for every *hot or cold* ferrous metal handling job: billets, slabs, ingots, scrap, plate, coils, sheets, rails, wheels, etc. Round magnet sizes range from 12 to 65 inches diameter. Rectangular Ohio Magnets are available in sizes from 25 to 85 inches long.

Ohio Magnets feature heavier construction for *longer life.* This extra weight is *distributed* throughout copper coils, insulation and steel frame —for greater lifting efficiency.

Here's an important maintenance feature too. Ohio chain ears last longer because they have *square holes* for chain pins to eliminate friction.

Many Ohio Magnets sold 25 years ago are *still in use . . .* still cutting costs. They are an even better investment today. Call on Ohio: *a leader in magnetic materials handling.*

Ohio MAGNETS

also a leading name in the fractional H. P. motor field

THE OHIO ELECTRIC MFG. CO.

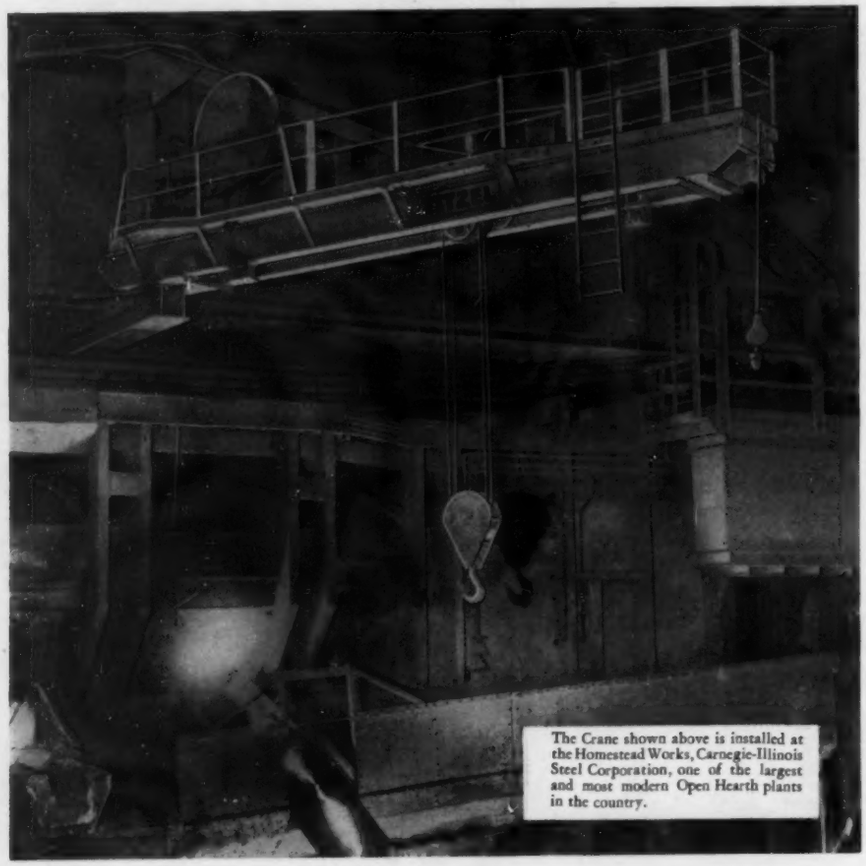
5907 MAURICE AVE. • CLEVELAND 4, OHIO

and coke handling equipment, by-product facilities, and a gas holder are included in the project. The new coke ovens will add 600 tons daily to the Midland output of blast furnace coke, bringing the total output to 1800 tons. The new facilities are expected to be in operation by October, 1948.

The battery of ovens will be of the Koppers-Becker type. In addition, the present Crucible ammonia recovery system will be completely modernized by the installation of two Koppers ammonium sulphate saturators, and auxiliary equipment.

The new coke ovens will be heated with blast furnace gas, and the blast furnace gas heating system also will be extended to a battery of 21 ovens now under construction.

Koppers also will build and erect at the site a 1,000,000 cubic foot gas holder for storing blast furnace gas, and will furnish a complete Koppers-Elex electric precipitator-type blast furnace gas cleaning plant.



The Crane shown above is installed at the Homestead Works, Carnegie-Illinois Steel Corporation, one of the largest and most modern Open Hearth plants in the country.

OPEN HEARTH EQUIPMENT, CRANES, JIB CRANES,
AND DOOR HOISTS
HUNT HYDRAULIC SYSTEMS AND AIR CONTROL VALVES
MEDART STRAIGHTENERS AND TURNING MACHINES
PALM OIL RECLAIMING SYSTEMS AND
CENTRIFUGAL SEPARATORS
CHEMICAL SYSTEMS AND CHEMICAL MACHINES
COAL AND ASH HANDLING PLANTS

Titzel Engineering & Equipment Co.

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132 Seventh Street, Century Building

DESIGNERS AND BUILDERS OF EQUIPMENT AND MACHINERY FOR STEEL MILLS AND INDUSTRIAL PLANTS

NEW BOILERHOUSE FOR JONES AND LAUGHLIN

▲ Jones and Laughlin Steel Corporation will erect a new boilerhouse at its Pittsburgh works. It is expected to cost in excess of $4,000,000.

The general contract for the boilerhouse was awarded to Rust Engineering Company. Babcock and Wilcox Company will furnish the steam equipment.

It is understood that the new boilerhouse, which will be a large structure, will replace several boiler installations the company now has at the Southside plant.

CURRENT TRANSFORMER FOR RELAYS AND METERS

▲ Designed for both relay and meter work, a new type CT-2.5 current transformer announced by Westinghouse Electric Corporation has class 0.3 accuracy with B-0.1, B-0.2, and B-0.5 burdens, the highest standard recognized by the American Standards Association (C-57) at price levels no higher than older type KO transformers suitable only for relaying. Impulse strength has been increased in the new line to 45 kv as added protection against lightning and switching surges.

Available for indoor use in the 2.5 kv class of insulation for operation on circuits of 2890/5000 volts or less, the transformer is produced in ratings from 10 to 800 amperes with a full-load secondary current of 5 amperes in all sizes.

The use of high-permeability Hipersil core steel in these transformers has made it possible to keep the size to a minimum while at the same time, accuracy and impulse strength have been improved markedly.

HEPPENSTALL EFFECTS HUGE SMOKE REDUCTION

▲ An 80 per cent reduction in smoke, reduced coal consumption, and a corresponding lowered volume of ash have been reported as the results gained by the Heppenstall Company in their effort to reduce industrial smoke in the Lawrenceville section of Pittsburgh. According to C. W. Heppenstall, Jr., vice president in charge

of operations of this steel forging plant, a small investment in time and materials has brought surprising results.

The company's largest boiler was shut down, so that alterations could be made. Five ¼ in. steam jets were introduced about 18 in. above the boiler's firebox. These pipes were inserted through 2 in. brick sleeves in the sidewalls of the boiler. The jets themselves are simple, being ¼ in. pipe plus a sleeve plus a pipe plug containing a $\frac{3}{32}$ in. hole. The boiler has three jets on one side and two on the other, all being connected to the boiler's 150 lb steam line.

The high pressure steam from the jets pulls air through the opening between the sleeve brick and the small pipe. This secondary air brought into the firebox is resulting in more complete combustion, and an almost entire elimination of clinkers among the reduced volume of ash.

The installation of the overfire jets in the company's main 858 hp stoker-fired boiler has been so successful that similar jets are being installed in three 400 hp standby boilers.

The Heppenstall executive welcomes inspection by other manufacturers of this installation, for which he gives the credit to suggestions found in Technical Report No. VII, prepared by Bituminous Coal Research, Inc. This report, "Application of Overfire Jets to Prevent Smoke in Stationary Plants," is available from the Bituminous Coal Research Agency at 912 Oliver Building, Pittsburgh 22, Pennsylvania.

FORM COMPANY FOR POWDER METALLURGY

▲ A new corporation devoted to consultation, research and development in the field of powder metallurgy, Sintercast Corporation of America, has been formed by Erwin Loewy, president of Hydropress, Inc., and two associates, Dr. Claus G. Goetzel and John Ellis. The new organization offers to industry a means of applying the latest techniques and newest developments in the rapidly-complicating field of powder metal parts production. Sintercast is currently establishing complete research and pilot-production facilities, so that it can carry clients' projects through labo-

A NEW BAR AND TUBE TURNER

✓ . . . automatic centering with roll-type positive, continuous feed

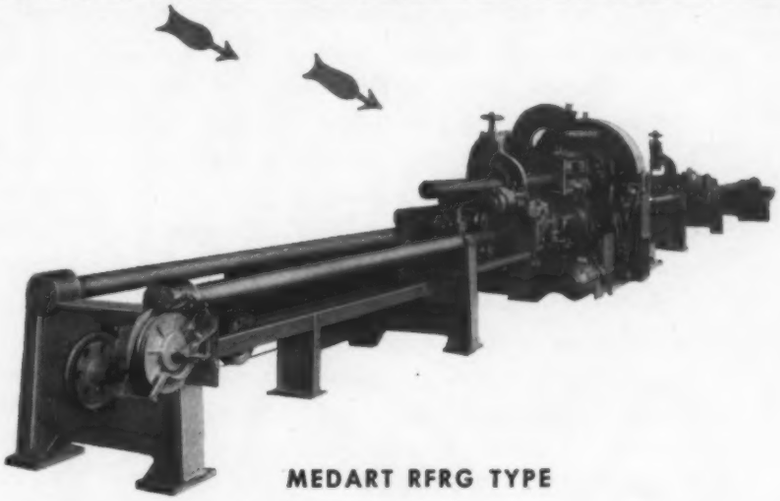
✓ . . . separate drives for cutting tool and bar feed for infinite ratios

✓ . . . two individual automatic-grip carriages

✓ . . . production on rough peel or precision work

✓ . . . 100% chip recovery

The new Medart RFRG type turning machine gives the exact ratio between cutting speed and bar feed rate for superior finish and close tolerance in precision turning, and high production on rough peeling or scalping. Speed and range of materials turned is limited only by the capacity of present day cutting tools. This new machine is completely push-button operated, and its improved, direct drive is actually simpler . . . easier to operate!



MEDART RFRG TYPE

MANUFACTURING ENGINEERS OF COMPLETE TRANSMISSION EQUIPMENT AND SPECIALIZED MACHINERY

MEDART

THE MEDART COMPANY . 3600 DEKALB ST. ST. LOUIS, MO.

"Joe's all in..."

but he Wasted Time Today...

Joe has just finished a fair day's work, and he's mighty tired—but it's a fact that he wasted time today. He stayed right on the job—no loafing for him—yet the time he spent lifting and lugging heavy materials and getting heavy work into his machine and out again was not productive time. There are many *Joes* in industry today, but their numbers are decreasing constantly, mainly because plant engineers are learning that continuous flow handling methods eliminate this inefficiency, and are applying these methods. A smooth, controlled flow of materials to machines goes a long way toward increasing production and keeping worker fatigue at a minimum. Mathews Engineers are specialists in continuous flow handling methods, and make available to American and Canadian industry the facilities of three modern strategically located plants, and the benefit of many years of experience in dealing with conveying problems in both light and heavy industry.

MATHEWS CONVEYER COMPANY
ELLWOOD CITY, PENNSYLVANIA

MATHEWS CONVEYER COMPANY WEST COAST
SAN CARLOS, CALIFORNIA
MATHEWS CONVEYER COMPANY, LTD.
PORT HOPE, ONTARIO

Engineering Offices or Sales Agencies in Principal American and Canadian Cities

ratory development to full-scale production.

Sintercast expects its most active fields of service to embrace: (1) the development of materials with unusual heat and corrosion resistant properties, (2) the evolution of processes and special equipment for manufacturing such materials, (3) the exploitation of new opportunities in the field of infiltration (casting one alloy into all the interstices and voids of sintered skeletons of other alloys), (4) the design and setting up of powder metal parts production departments for manufacturing firms, and (5) general consultation to help clients utilize up-to-date powder metallurgy to its fullest. Sintercast will even design a plant for powder metal parts manufacture, supervise its construction, and manage it until it is operating smoothly.

SHEET AND TUBE ADDS TO ANNEALING CAPACITY

▲ The strip annealing capacity at the Indiana Harbor, Indiana, mill of Youngstown Sheet and Tube Company, will be increased when 12 annealing furnaces are remodeled by Rust Furnace Company. The furnaces to be remodeled were built by Rust in 1937.

WEIRTON INCREASES COKE PLANT CAPACITY

▲ Weirton Steel Company has put into operation a new battery of 53 Koppers-Becker ovens, increasing its output of coke by 850 tons per day, it was announced by Koppers Company, Inc. A second battery of Koppers-Becker ovens of similar capacity will be put into operation at Weirton within two months, officials said.

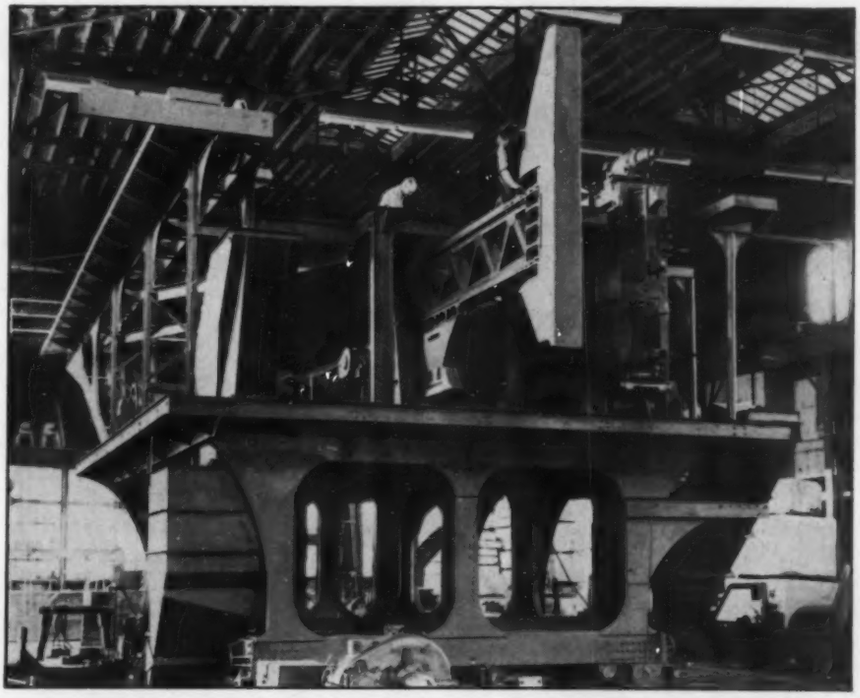
Both new batteries have been under construction since April 1946, by the engineering and construction division of Koppers Company, Inc. They are the latest type under-jet ovens, equipped with gas recirculating ducts and blast furnace gas underfiring equipment. Auxiliaries such as equipment to recover ammonium sulfate, tar, light oil and gas also are under construction or have been completed.

Weirton's first by-product coke ovens were constructed in 1922 when 37 were built. Forty-nine more were

RELIANCE SHIPPING FROM ASHTABULA PLANT

First motors to be manufactured in the new Ashtabula (Ohio) plant of the Reliance Electric and Engineering Company were packed for shipment under the personal direction of company executives. J. W. Corey, president, manipulates mechanical bander as F. E. Harrell, manufacturing vice-president, Karl H. Meyer, Ashtabula plant manager, and R. H. Smith, company secretary, look on. The new plant will be used for the production of 1 to 15 hp electric motors and V-S drives.

COKE PUSHER SHOVES 15-TON CHARGES



This 150-ton coke-pusher, shown nearing completion in Koppers Company, Inc., shops division, will shove 15-ton charges of coke from steel mill ovens. The pusher operates on a track running beside the ovens. Equipment at upper right, including the two cylinders that look like trench mortars, automatically loosens and removes the heavy coke oven doors. The huge ram (center) then pushes the glowing coke through the oven into a waiting steel car. This latest-type coke-pusher is entirely mechanical and can be operated by one man. It is run by 12 motors, ranging in size from 65 to 2¼ hp.

constructed in 1926, 25 more in 1930, and 45 in 1941. When the second of the two 53-oven batteries now under construction is put into operation, Weirton will have a total of 262 by-product coke ovens with a total capacity of 3400 tons of coke per day and adequate handling of by-products. All of the Weirton by-product ovens are of the Koppers-Becker type.

BASIC TO REPRESENT GATHMANN MOLDS

▲ Gathmann molds and methods of steel ingot production are to be represented exclusively by Basic Refractories, Inc., of Cleveland, according to an announcement by Mark Gathmann, vice president of the Gathmann Engineering Company. "The new selling arrangement is effective immediately and is expected to result in increased service to all our customers," he stated.

Gathmann service, established in 1909, has been responsible for many new developments and improvements in the design and construction of molds and the production of ingot steel — one of the best known Gathmann innovations being the "big-end-up" design.

The connection with Basic Refractories, Inc., a leading producer of granular-type basic refractories, brings together two long-time suppliers to the steel industry with recognized records of research and pioneering effort for the betterment of quality in steels.

REFRACTORIES MEETING AT BEDFORD SPRINGS

▲ The refractories division of the American Ceramic Society has arranged a symposium on special refractories including the refractory oxides and carbon for their Fall Meeting at the Bedford Springs Hotel, Bedford, Pennsylvania. The program is built around those refractories which became of greater interest during the war years, in part due to research in the fields of atomic activity and jet

"MULTICUT" "TUFCUT" "HOT WORK"
Wapakoneta
SHEAR BLADES
and ROTARY KNIVES
Any type or size blade of proper Alloy with correct hardness and temper for every type shearing machine and every kind of job.
Rx ENGINEERED TO THE JOB
Every Wapakoneta blade is made to exact specifications, designed for the particular job. Complete records with order number of each blade makes possible duplication of exact size and temper at any time.
The WAPAKONETA MACHINE CO.
Shear Blade Specialists Since 1891
Wapakoneta, Ohio

propulsion. The meeting is open to everyone and it is hoped that it will be useful to those chemists and physicists who have recently become interested in the field of high temperature refractories.

The Technical Session, to be held Friday afternoon, October 10, is as follows:

1. Introduction to the Study of the Refractory Oxides, Raymond E. Birch, Harbison-Walker Refractories Company.
2. Simple Oxide Porcelains for Jet Planes and Projectiles, R. F. Geller, National Bureau of Standards.
3. Properties and Uses of Mullite and Pure Alumina Refractories, G. Bickley Remmey, Richard C. Remmey Sons Company.
4. Zircon and Zirconia Refractories, William J. Baldwin, Titanium Alloy Manufacturing Company.
5. Carbon as a Refractory Material, F. B. Thatcher, Great Lakes Carbon Corporation.

Organized social activities are scheduled for Friday evening and Saturday, October 11. Additional information on transportation or other aspects of the meeting may be obtained from Mr. Collin Hyde, chairman of the transportation committee, Harbison-Walker Refractories Company, Hays Laboratory, Pittsburgh 7, Pennsylvania.

GAS THERMOMETER MEASURES 5000 R

▲ Fairchild Camera and Instrument Corporation has announced the new Fairchild pneumatic temperature measuring system, for measurement and control of extremely high gas temperatures to 5000 degrees, Reaumur. The instrument is a form of gas thermometer utilizing the density of the gas being measured as a direct indication of the temperature.

The Fairchild corporation claims this method can solve specific gas measurement-control problems encountered in a broad variety of fields, including aircraft, marine, railway, and general industrial. Instruments are also available for laboratory use.

The new system is not subject to the usual radiation effects common to present temperature sensing methods. It can be applied for temperature measurement and control wherever a

(*Please turn to page 118*)

Mass Lubrication for Mass Production

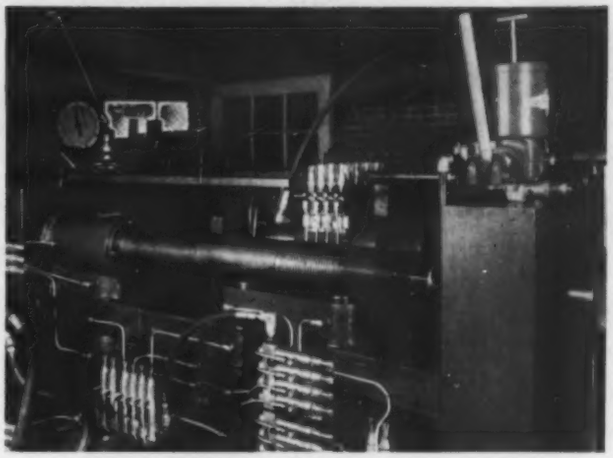
made easy with

LINCOLN

CENTRO-MATIC LUBRICATING SYSTEMS

Specifically engineered for flexibility of application, simplicity of installation, and dependable operation, these *single line* centralized lubricating systems deliver oil or grease to bearings by positive displacement, under line pressure, providing greatest assurance of proper lubrication—in seconds instead of hours. All that is required is a Centro-Matic Injector for each bearing, arranged singly or in manifold, and connected by only a *single lubricant line* to a Centro-Matic Lubricant Pump. Illustrated below are the various types of injectors, pumping units and accessories from which a selection can be made to meet the particular requirements of a single machine or a battery of machines.

Save bearings . . . Power . . . Machine Hours . . . Man Hours and prevent accidents—install Centro-Matic Systems on all of your plant equipment that requires periodic lubrication.

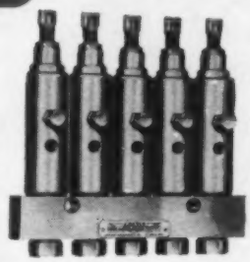


A Lincoln Centro-Matic System on a Die Casting Machine.

TYPES OF INJECTORS...

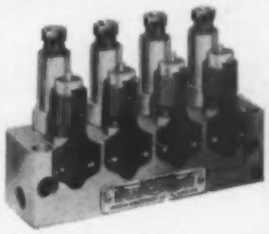
LINCOLN SERIES SL-1 INJECTORS

Available in two types, the No. 81713 for individual mounting and the No. 81713A for mounting in manifold. Injectors will handle lubricants ranging from machine oils to fibrous greases. Lubricant output adjustable up to .04 ozs. Units include External Adjusting Nut, Indicator Stem, and Fitting for initial filling of feeder line and visible check on quantity of lubricant discharged. Manifold assemblies are available with from 2 to 5 injectors, and may be mounted vertically or horizontally. Any combination of manifold units may be connected in series or mounted one above the other.



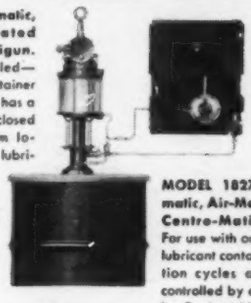
LINCOLN SERIES SL-3 INJECTORS

Compact, space-saving design of the Series SL-3 Injectors makes them especially desirable when mounting space is limited. Injectors in manifolds of two, three and four units are provided where conditions favor group mounting. Discharge of injectors is by positive displacement. Units include Adjusting Knob with spring clip-lock and Indicator Stem. SL-3 Injectors may be mounted vertically or horizontally, and any combination of same can be connected in series, as with the SL-1 Injector. Lubricant output adjustable up to .004 ozs.



TYPES OF PUMPING UNITS...

MODEL 1825 Automatic, Air-Motor Operated Centro-Matic Lubrigun. Automatically controlled—manually timed. Container capacity 60-lbs. Unit has a compact, totally-enclosed pumping mechanism located beneath the lubricant container.

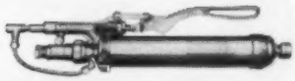


MODEL 1827 Full Automatic, Air-Motor Operated Centro-Matic Lubrigun. For use with original 400-lb. lubricant containers. Lubrication cycles automatically controlled by automatic Timing Device with signal alarm.

MODEL 1840 Full Automatic, Electric-Motor Operated Centro-Matic Lubrigun. Lubrication cycles automatically controlled by Timing Device. Motor—110 Volts A. C. 60 cycle, single phase. Container capacity 30 lbs.

MODEL 1806 Manually Operated Centro-Matic Lubrigun. Capacity 10-lbs. Has large button head fitting for attaching Filler Pump Hose.

MODEL 1805 Manually Operated Centro-Matic Lubrigun. Capacity 2-lbs. Has large button head fitting for attaching Filler Pump Hose.



MODEL 1807 Portable, Manually Operated Centro-Matic Lubrigun. Capacity 1-lb. Spring Primed. Unit includes 18" Whip Hose Assembly.

ACCESSORIES...

A complete line of installation accessories—copper tubing, high pressure, flexible lubricant hose, fittings, clips and everything needed to make the installation are available.

Write for Bulletin . . .

Mail coupon for your copy of illustrated Bulletin No. 801. It gives you full information on the newest developments in Centralized Lubrication. Our lubrication engineers are ready to assist you in solving your lubricating equipment problems. We invite you to make use of this service.

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Pioneer Builders of Engineered Lubricating Equipment

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Please give me information on Centro-Matic Systems for (type of machine)_____. Send me your new Centro-Matic Bulletin 801 ☐ Catalog on Industrial Lubricating Equipment. ☐

Name_____

Title_____

Company_____

Address_____

City_____ State_____

ISE B47-16

(*Continued from page 116*)

small quantity of the high temperature gases to be measured or controlled can be continuously sampled.

Specified accuracies for these instruments are plus-or-minus 1 per cent to 2500 degrees R., and plus-or-minus 2 per cent from 2500 to 5000 degrees R., with a response rate of ½-second or less.

STEEL AND WIRE FIRM ADDS BILLET FURNACES

▲ Two billet heating furnaces at Joliet, Illinois, works of American Steel and Wire Company will be reconstructed by Rust Furnace Company. The furnaces at this U. S. Steel subsidiary plant will be extended to accommodate an increased number of billets, necessary to compensate for the proposed increase in speed of the plant's No. 1 and No. 2 continuous rod mills.

COMMERCE DEPARTMENT REVEALS GERMAN DATA

▲ The Department of Commerce, in cooperation with the War Department, England, France and other wartime Allies, has brought to the United States from Europe approximately 5000 reels of microfilm of German technical industrial data, including 145,000 patent applications. The microfilm represents the most important detailed data upon German technology that has been obtained.

However, with this wealth of informative material at hand the Department of Commerce needs the assistance of qualified groups and individuals in determining the relative importance of various topics, and later, in reviewing and evaluating the documents.

Although no funds are available to compensate for this assistance, the data are sufficiently valuable so that groups and individuals should feel it to be of great professional interest to join with the Department in preparing the information so it can be assimilated by industry. Reviewers and evaluators will have the benefit of the detailed and immediate scrutiny of the original German material, and they will be permitted under the Department's auspices to write professional articles for publication. The articles also will be included in a forthcoming government compendium of German wartime technology.

The Department of Commerce wishes the names, addresses and specific fields of activity of individuals among AISE membership who might serve as evaluators. If interested please contact the headquarters of the AISE, 1010 Empire Building, Pittsburgh 22, Pennsylvania.

J & L BUYS LARGEST MECHANICAL PRESS BRAKE

▲ Completion of the world's largest mechanical press brake was announced by the Warren City Manufacturing Company. The first unit is being delivered to the McKeesport, Pennsylvania, plant of the Jones and

FOR THE SAFETY OF YOUR WORKMEN . . .
use
Bailey
MECHANICAL
GOGGLE
VALVES
SIZES 6" TO 72"
The totally enclosed type, 6 inch size.
EASY OPERATING
POSITIVE SHUT-OFF
The powerful clamping device of Bailey Mechanical Goggle Valves assures a gas-tight seal when closed, and prompt, positive freeing of plate when valve is to be opened, regardless of time between operations.
Made in sizes from 6 inches to 72 inches; totally enclosed if desired.
Write for complete details and dimensions of Bailey Mechanical Goggle Valves.
A 60" x 48" Bailey Valve for horizontal gas main.
FOR GAS WASHERS, GAS MAINS, COKE PLANTS
WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
PITTSBURGH PENNSYLVANIA

The size of this brake is indicated by the number of men seated on it.

Laughlin Steel Corporation, whose engineers cooperated in its design.

Of fully stress-relieved welded steel construction, the "Warco" press brake weighs in excess of 500,000 lb without dies. The machine is designed to exert a pressure of over 1000 tons for bending to a right angle in a single stroke steel plate 5/8 in. thick in lengths up to 36 ft. The brake, which makes 15 strokes per minute, has all moving parts counterbalanced by air cylinders. The machine's flywheel, weighing over 10,000 lb, and rotating at 450 rpm, is driven by a 75 hp electric motor. This huge machine is controlled by an operator stationed at a finger-tip control electrical push button station. Setting of the ram is also electrically controlled by means of a push button control with indicators showing the exact ram setting within one-thousandths of an inch. All lubrication is centralized from one position.

Owing to the great weight and size of the unit, over 36 ft long, 16 ft front to back, and 20 ft high, the brake is being dismantled for shipping in five separate freight cars. The four bodies, each weighing over 50,000 lb, are being shipped in special well cars so as to provide sufficient clearance.

MOVE SKID PLATFORMS WITH ALL-PURPOSE TRUCK

▲ Making it possible to handle skid platforms of all heights with a single all-purpose motorized hand truck and without blocks, the Hyskid Transporter is announced by Automatic Transportation Company. Featuring a vertical hydraulic lift which raises the platform a net lift of 13 in., from 6 in. above the floor in low position

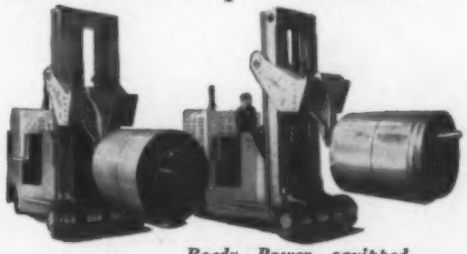
(*Please turn to page 122*)

more power WITH READY-POWER

Ready - Power - equipped Elwell Parker Up Ender handling heavy steel coils.

FOR ELECTRIC TRUCK OPERATION AT ITS BEST!

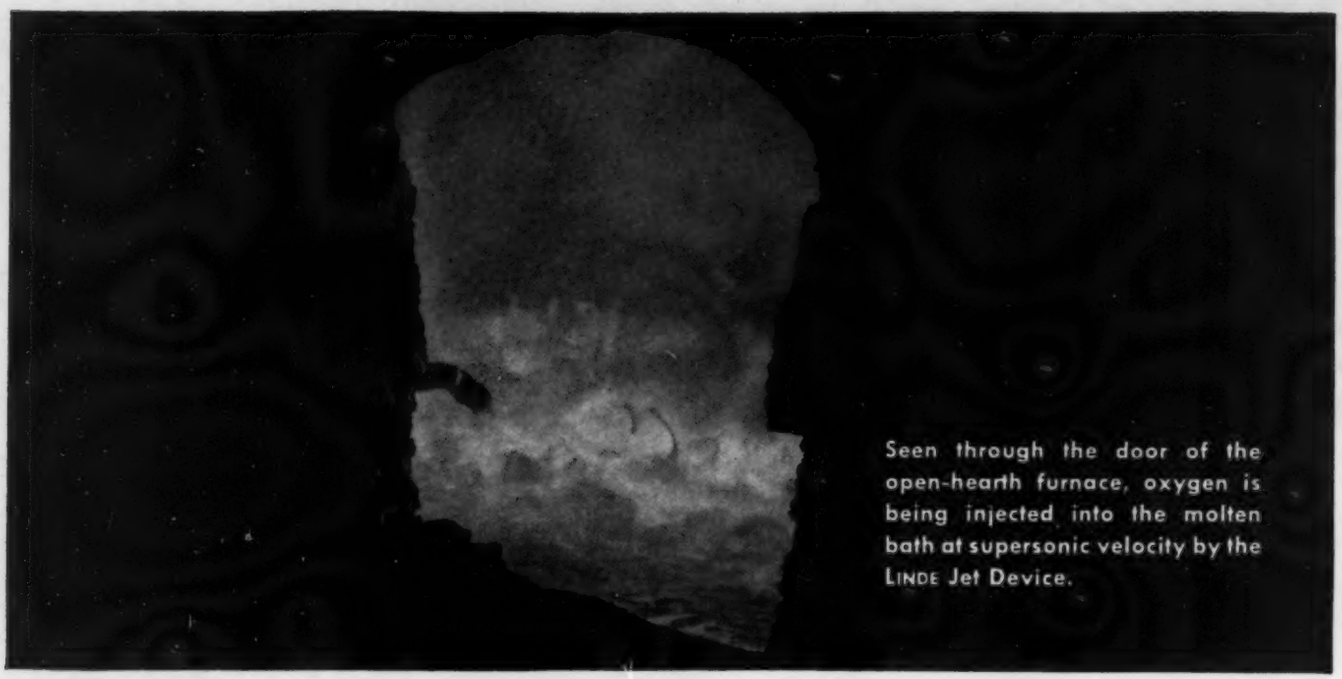
Ready-Power-equipped electric trucks provide more power for heavy loads, more continuous hours of service and more materials handled in any given period. Dependable electric power is generated right on the truck chassis by an engine-driven, direct-current generator. Get the most out of your electric trucks. Convert them to Ready-Power. Specify Ready-Power on your new trucks. Write for descriptive literature.



Ready - Power - equipped Automatic Ram Trucks handling steel coils.

THE READY-POWER CO.

3836 Grand River Ave., Detroit 8, Michigan



Seen through the door of the open-hearth furnace, oxygen is being injected into the molten bath at supersonic velocity by the LINDE Jet Device.

What's the Story on OXYGEN in Steel-Making Furnaces?

ONLY THE FIRST CHAPTERS OF THIS STORY have yet been written—promising though they appear. To date LINDE has co-operated with steel companies in obtaining data on more than 6,000 heats in 34 furnace shops as a part of an experimental program on oxygen use in steel-making furnaces. From all these data the basic fact stands out that the periods of scrap melt-down and of refining can both be shortened appreciably.

Already credited to LINDE are the development of a number of burner designs, the new idea of direct scrap melt-down with a high-velocity jet of oxygen, and a non-consumable device for introducing an oxygen stream for decarburization and scrap melt-down that may lead to mechanization for these parts of the process.

For the test program LINDE's DRIOX high-purity liquid oxygen was used because it was readily available at a price that made these tests economically practical. Anticipating the use of oxygen of lower purity,* LINDE has built, and operated for nearly a year a producing unit that has a capacity of about 200 tons per day of 90 per cent purity gaseous oxygen, the largest single unit ever built.

This makes the story of oxygen use in steel-making a promising one, although problems in furnace operation and in oxygen supply must be solved before economic advantages are assured.

Although the final chapters of this story are in the realm of conjecture, LINDE's extensive facilities for research and development will continue to be concentrated on this program so that the steel industry may benefit as knowledge is gained.

*Cost of low-purity gaseous oxygen will depend on purity, quantity, and pressure required; size of storage facilities; and other demand characteristics.

Management and production executives are invited to write for the factual report which LINDE *has prepared on oxygen use in steel-making furnaces. Please address Room 308, 30 E. 42nd St., New York 17, N. Y.*

Linde
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Unit of Union Carbide and Carbon Corporation
30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities
In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

The words "Linde" and "Driox" are trade-marks of The Linde Air Products Company

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. . . . MECHANICALLY
. . . . ELECTRICALLY
} Right

SWINDELL

ELECTRIC ARC MELTING FURNACES

FOR YOUR MOST INTENSIVE SERVICE REQUIREMENTS

A SWINDELL engineer will be glad to discuss your furnace needs.

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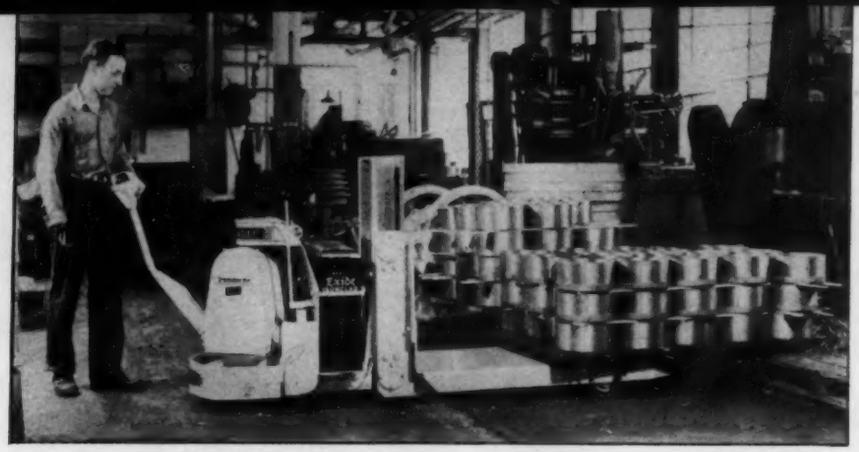
DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES

PITTSBURGH 30, PA.

(*Continued from page 119*)

to 19 in. in raised position, the new model Transporter has the highest lift of any motorized hand truck ever built for horizontal handling. It will handle all skids, from the lowest to the highest used in industry — and still leave ample clearance to negotiate ramps.

Virtually all other motorized hand trucks — including both those with vertical and link lift — raise a maximum of only four to six inches, making it necessary either to use separate trucks or to build up the platform with blocks in order to handle skids of various underclearances.



This new all-purpose truck can handle skid platforms of all heights without blocks.

The new Transporter is equipped with the standard ATCO electric lift motor, which actuates a vertical hydraulic piston. It will raise a full-capacity load of 6000 lb at a rate of slightly more than one in. per sec. It will raise the full 13 in. in 12 seconds loaded or 8 seconds empty. In actual use, however, the operator will adjust the platform height while traveling empty when handling skids of various heights, making it necessary to raise the platform only an inch or two when picking up a load.

Despite its unusual lifting height, the new lift's power consumption is so low that the truck uses the same standard 11-plate battery as all other Transporters. The new model will be made in both 4000-lb and 6000-lb load capacities.

CLAIRTON OPENS REBUILT COKE OVEN BATTERIES

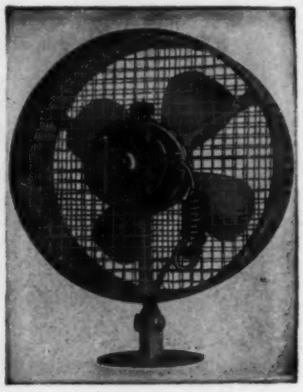
▲ The current coke shortage, which has curtailed blast furnace production in the Pittsburgh district, was relieved substantially when the first coke is pushed August 29 from the ovens of rebuilt battery No. 21 at Clairton works of U. S. Steel's Carnegie-Illinois Steel Corporation.

The new battery consists of 87 Koppers-Becker underjet type coke ovens with self-sealing doors and double collecting mains. It has a total carbonizing capacity of 2500 tons of coal a day, while the entire Clairton by-product coke plant, largest in the world, has a daily coal carbonizing capacity of 30,000 tons.

Battery No. 21 is the second of two units rebuilt by Koppers Com-

(*Please turn to page 125*)

IS HEAT SLOWING UP YOUR WORKMEN?



TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep Them COOL with TRUFLO FANS

TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

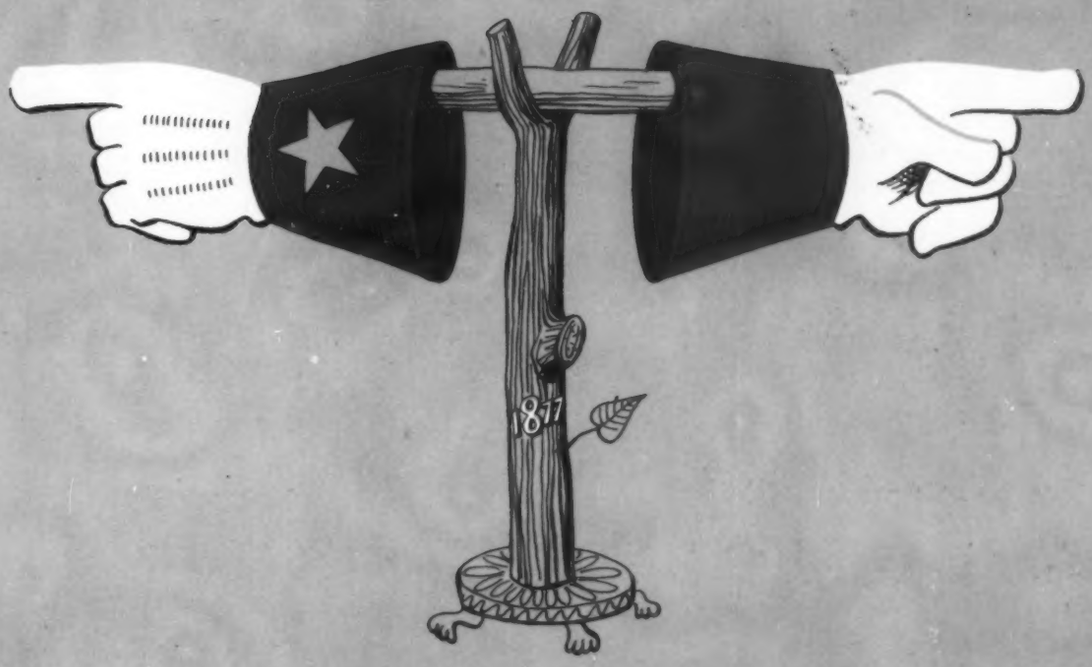
Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY
554 MAIN ST., HARMONY, PA.

We built the first reversing blooming mill . . .

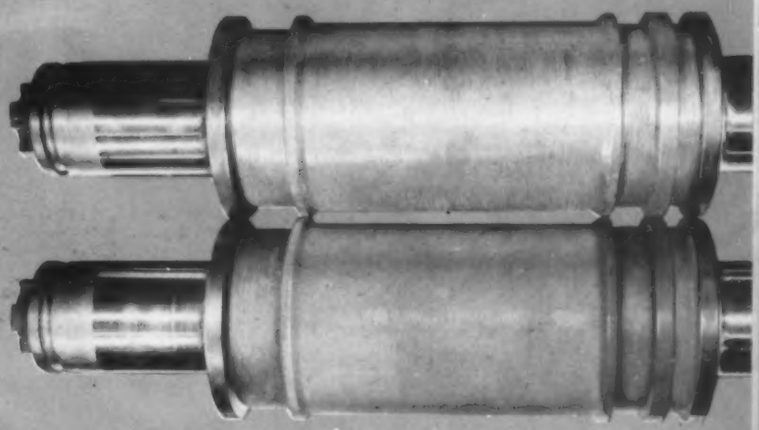


So what? We've been pioneers in developing many types of rolling-mill equipment—so what?

So we've learned, by experience, that metal-rolling is an industrial art—that successful rolling-mill production is dependent upon the skill of the operator *in the proper use* of *the proper rolls.*

Your own rolling experience dictates *the proper use* of rolls; *the proper rolls,* Mackintosh-Hemphill rolls, are engineered by mill-wise Mackintosh-Hemphill to your own specifications based on your own production requirements.

You know your mills—Mackintosh-Hemphill knows roll manufacturing. Let's get together.



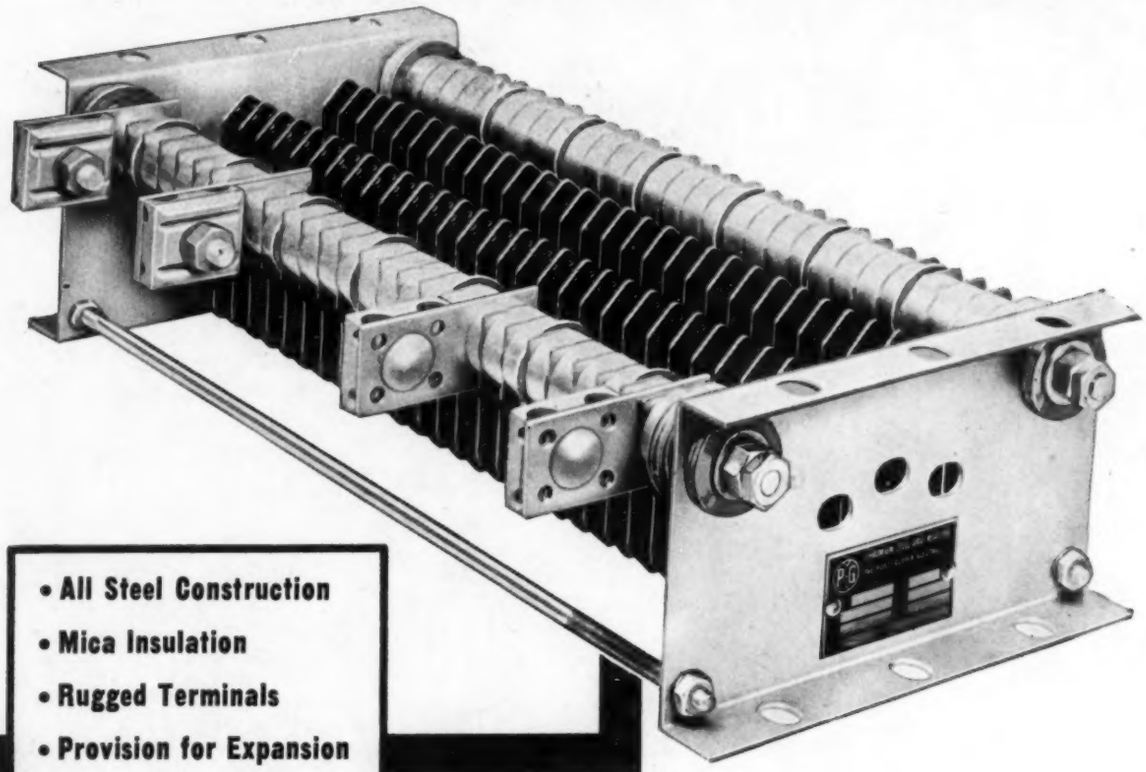
MACKINTOSH-HEMPHILL CO.

PITTSBURGH AND MIDLAND, PENNSYLVANIA

Makers of the rolls with the Red Wabblers

A Grid Design

TO ELIMINATE HOT SPOTS . . .
and INSURE EVEN HEAT DISTRIBUTION!



- All Steel Construction
- Mica Insulation
- Rugged Terminals
- Provision for Expansion
- Adequate Ventilation
- Unaffected by Vibration or Moisture
- Corrosion Resistant

The unique shape of P-G Resistor Grids permits unusually even heat distribution over the entire grid surface. Since each part of the resistor element has relatively equal exposure to the air, heat is rapidly dissipated and hot spots fail to develop. For trouble-free, heavy-duty service, you can safely specify P-G.

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

(*Continued from page 122*)

pany at Clairton, the rebuilding of identical battery No. 22 having been completed a year ago. These two batteries have the largest capacity per oven in the United States, each of the ovens being charged with 22 tons of coal.

Work on the new battery was commenced slightly less than one year ago and was rushed to completion because of the current shortage of coke used for smelting iron ore in the blast furnaces.

The rebuilding of 21 and 22 batteries is part of a general modernization program at Clairton designed eventually to replace all of the old batteries with modern equipment.

PHOENIXVILLE PLANT JOINS WITH APOLLO

▲ In a move to beat the steel shortage, a syndicate of twenty-five manufacturers throughout the country has purchased an ingot-producing steel mill at Phoenixville, Pennsylvania, for approximately $4,000,000.

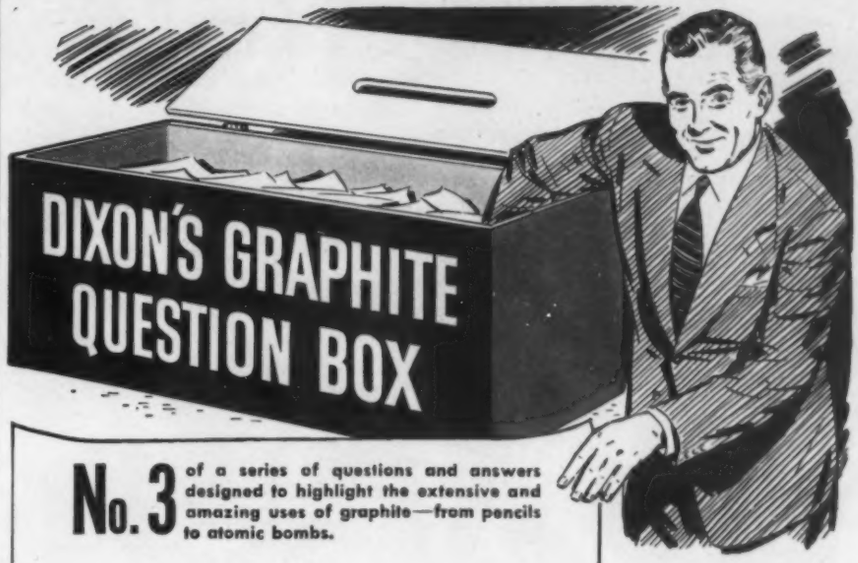
The purchase was made in order to supply ingots for a sheet mill at Apollo, Pennsylvania, which the syndicate bought when it was organized last December. The new acquisition completes a program for meeting the manufacturers' steel needs.

The mill, with a capacity of 30,000 tons of ingots a month, is the Phoenix Iron Company, purchased by the Phoenix-Apollo Steel Company, comprising a group of manufacturers from New York to California, whose products range from kitchen stoves to lawn mowers and from furniture to advertising signs.

The mill, which contains six open hearth furnaces and three rolling mills, will provide enough steel to enable all manufacturers in the group to operate at full capacity while all excess steel will be sold to other consumers.

Sheet bars from the Phoenixville mill will be rolled into sheet steel at the Apollo mill, formerly the Apollo Steel Company. Both mills have a total appraised value of $11,000,000.

The management of the Phoenixville mill will be retained. David Thomson, president of the Phoenix Iron Company, will serve as general manager under the new ownership. Howard Keiser, formerly of the Ports-



No. 3 of a series of questions and answers designed to highlight the extensive and amazing uses of graphite—from pencils to atomic bombs.

GRAPHITE IN THE ROLLING MILL

QUES. How have many metal-rolling mills reduced power costs up to 25%?

ANS. By using proper types of graphite roll neck greases.

QUES. What accounts for such large savings?

ANS. 1. Graphite, a "solid" lubricant, resists the high bearing pressures which force ordinary lubricants out of the bearing.

2. Graphite fills the irregularities that exist on roll neck and bearing.

3. This graphite film is more readily "wetted" by the oil in the grease.

4. The graphite reduces the internal friction within the grease.

5. By reducing friction, bearing maintenance costs are also reduced.

6. Cooler and better-controlled roll neck temperatures permit closer tolerances, more uniformly finished products.

QUES. Has graphite grease performance been proven by actual tests in rolling mills?

ANS. Definitely yes. Convincing test records and data obtained over the years fully support claims of superiority made for graphite greases.

QUES. Why is graphite or a graphited lubricant considered a "No. 1 must" in the power plant or other plant areas having similar equipment?

ANS. Its resistance to destruction or displacement by heat and pressures, water and solvents assures continuity of power output at minimum operating cost.

A few of thousands of widely used products containing Dixon's Graphites. Those starred are Dixon's products, many of them sold by supply houses everywhere.

★ Lubricating and Penetrating Oil

★ Pipe Joint Compound

★ Graphite (pipe joint) Seal

Now may we receive *your questions* on how graphite can help *you*?

DIXON'S GRAPHITES

Products of
JOSEPH DIXON CRUCIBLE COMPANY
Jersey City 3, N. J. Div. 18-Q-9

LOOK FOR No. 4
in this series. We will gladly send you reprints of any you may miss

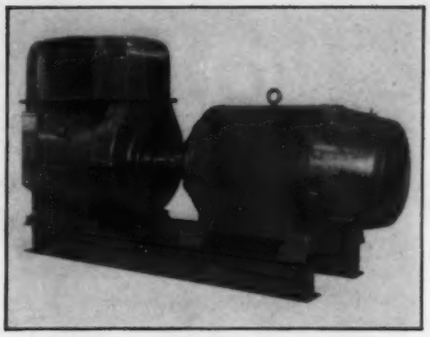
mouth division of the Wheeling Steel Company, is manager of the Apollo mill.

UNIT-COOLED GENERATORS FOR STEEL MILL USE

▲ A new line of totally-enclosed, unit-cooled generators has been announced by the motor divisions of the General Electric Company for use in motor-generator sets or in other generating applications in any non-hazardous atmosphere where the ratings involved make totally-enclosed fan-cooled construction impractical.

The new generators are available in ratings from 30 to 150 kw. They are especially suitable for use in atmospheres commonly found in steel mills, cement mills, paper mills, and around large machine tools.

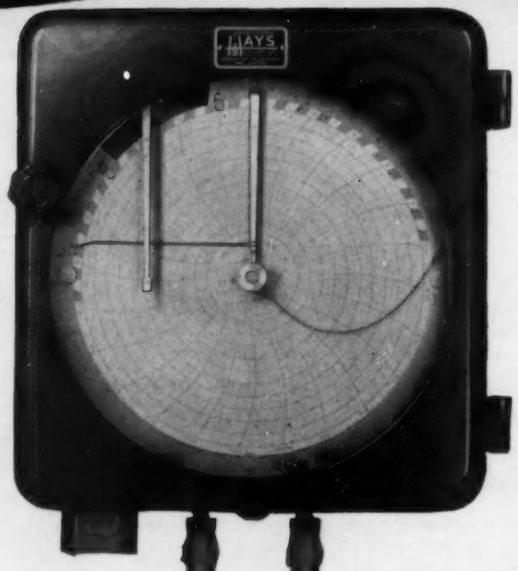
Cooling of the generator is accomplished by an air-to-air surface cooler Which maintains safe winding temperatures at all times. When used in a motor-generator set with a G-E totally-enclosed unit-cooled d-c motor, the entire unit is completely assembled at the factory and shipped ready for installation.



Cooling is accomplished by an air-to-air surface cooler.

A Practical Means TO CLOSER QUALITY CONTROL

The HAYS "OT" Pressure Recorder



THIS dependable instrument is proving itself invaluable to the steel industry . . for maintaining proper atmospheres in soaking units, annealing furnaces, open hearth furnaces, slab mills, and any place where an accurate record of draft, pressure or differentials is required.

You get an errorless record of two draft values, two pressure values, two differential values, or any combination of two of those values.

A good many new and modernized open hearth installations are equipped with Hays Series "OT" Pressure Recorders . . . as a simple, dependable, practical means to closer quality control.

Step 1 toward getting the benefits of this modern quality control is to get the facts about it. Bulletin 43-586 tells them . . . better send for it.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA U.S.A.

REPUBLIC ACQUIRES GOVERNMENT FACILITIES

▲ Republic Steel Corporation has acquired government-owned facilities at Warren and Youngstown, Ohio, according to officials of the War Assets Administration. At Warren, Republic bought the by-products coke oven plant for $3,864,000, and leased the property in Youngstown for 10 years. The Warren facility includes about 17 acres of land, 61 Wilputte coke ovens, pusher machine, quenching car and locomotive, by-products and purification equipment, sulphate equipment and sintering plant complete. The plant has a rated capacity of 392,000 tons of sintered concentrates and 325,000 tons of coke per year. Republic leased the Youngstown property, which covers 6 acres and includes a blast furnace with a rated capacity of 392,000 net tons of pig iron a year, a power plant and other facilities.

UNCOILING MANDREL REROLLS METAL STRIP

▲ An uncoiling mandrel with simple and positive expansion mechanism has recently been designed and built by Farrel-Birmingham Company, Inc., for use in rerolling semi-finished metal strip.

Expansion is accomplished by the action of a series of longitudinal blades, which are actuated by two traversing cones within the mandrel.

This uncoiling mandrel is operated by a large handwheel.

Operated by a large handwheel on the end of a double screw with threads of opposite hand, the cones engage the inner surface of the blades, pushing them outward so that they grip the inside of the coil. Springs retract the blades when the cones are backed off.

The mandrel is carried in anti-friction bearings mounted in a heavy pedestal, and a friction brake of sturdy design provides required back tension. The mandrel slides on ways in the baseplate and can be moved into or out of position by a rack-and-pinion mechanism operated by a ratchet wrench.

DOUBLE IMAGE-SIZE IN OPTICAL PYROMETER

▲ The size of the image which an operator sees in the Leeds and Northrup Company optical pyrometer can now be made twice as large as the standard instrument provides, simply by using a new objective lens assembly.

This increased size is particularly useful in measuring the temperature of thin or small-area objects. It makes the brightness match between the hot object and the optical's "disappearing filament" considerably easier to obtain, in cases where the target would otherwise appear almost as small as the filament.

Typical applications where the larger image is handy in open hearth shops are in measuring tapping temperatures by sighting at the darker streak at the center of the tapping stream, and in reading temperature during spoon tests by sighting at the narrow ribbon of metal pouring from the spoon.

Heat-beating Deltabeston magnet wire is made in round, square, and rectangular shapes in a wide variety of sizes.

. . . TO HELP YOU
BEAT THE HEAT

Wherever heat is a threat to motor operation, wherever high temperatures call for windings that can "take it," be sure that your motors get the extra protection of Deltabeston* magnet wire. It's real protection for motors that work near installations such as furnaces and strip mills. It's your assurance that motors will withstand severe operating conditions. For your specific needs, there's a Deltabeston magnet wire, built to help your motors beat the heat.

And beating the heat is only part of the heavy-duty job that Deltabeston does. It's built to protect your motors from moisture, corrosive vapors, oil, and other destructive conditions that so often go with high heat.

Whether your motors are rewound in your plant or in an outside repair shop, insist on Deltabeston asbestos- or glass-insulated magnet wire. You'll get more service, less maintenance, and you'll add extra years of life to your motors.

For information on General Electric asbestos, glass, and synthetic wires, write Section Y57-946. Appliance and Merchandise Department, General Electric Company, Bridgeport 2, Connecticut.

*Trade-mark Reg. U. S. Pat. Off.

GENERAL ELECTRIC

INTRODUCE NEW LINE OF ROTARY PUMPS

▲ A new line of general service rotary pumps, the GA rotary type, has been introduced by Worthington Pump and Machinery Corporation. Six sizes are available in various mountings for capacities up to 51 gpm and 100 psi.

These small capacity rotary pumps have been designed for durability under severest service requirements, and adaptability to variety of such requirements offered by industries. Design features include four bearing construction and special herringbone rotors. Built-in pressure lubrication eliminates all external lubrication and the danger, prevalent in many industries, of liquid contamination. A production line item, the GA rotary in its simplicity of design also offers easy maintenance and low first cost.

Models are available foot mounted or flange mounted with adjustable stuffing box and mechanical seal. They are also available with or without oversize unloader type relief valve. All models are suitable for direct coupling to electric motors of any make.

Services include: Lubrication of rolling mills, circulation of quenching oils and coolants, low pressure hydraulic lifts.

FUNCTIONAL PAINT PREVENTS CORROSION

▲ Protection against corrosion and scale at higher temperatures than ever before is the prime advantage of the Markal Company's new heat-proof paint. It is a functional paint and will prevent hot metals from corroding and scaling at red hot temperatures as high as 1850 F. It will provide protection to metals in all weather conditions.

The hot metal can be subjected to sudden temperature changes such as quenching immediately in cold water without cracking or peeling of the paint. This paint follows the contractions and expansions of the metal at all temperatures.

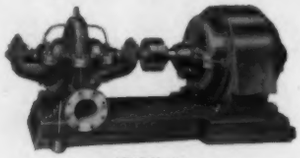
It is ideal for smoke stacks, annealing boxes, exhaust manifolds, furnace pipes, mufflers on trucks and tractors, etc. The paint is applied while the parts are cold. It dries in about 20 minutes and can be subjected to the red hot temperatures immediately after drying. Emphasis is placed on the fact that this product is not merely heat-resistant, but positively heat-proof.

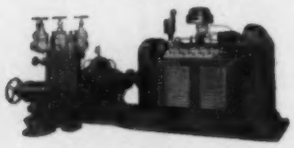
ALL-DOOR FURNACE FRONT ON OPEN HEARTHS FOR USE

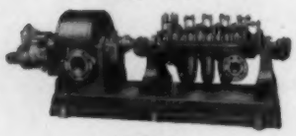
▲ After five years' service experience with all-door furnace front on seven large "in-and-out" type slab reheating furnaces, Frazier-Simplex, Inc., Washington, Pennsylvania, believes it can be made to work successfully on open hearth furnaces. Especially so, on those furnaces which now use a suspended roof in silica or basic.

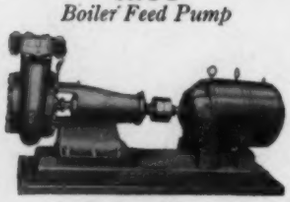
Since the basic roof will not withstand the cooling down necessary to hot patch a front wall, it appears as though its success may be dependent on the elimination of the front wall. The all-door front does this very thing, and in addition permits the use of a larger charging box. Let's see

Where there's a PUMP in your Plan
SPECIFY
PEERLESS


TYPE A
General Service Pump


TYPE AF
Fire Pump Underwriters' Approved


TYPE B
Boiler Feed Pump


TYPE DS
Process Services Pump

PEERLESS CENTRIFUGAL PUMPS ARE MANUFACTURED IN AN EXTENSIVE SERIES OF ADVANCED TYPES, SIZES AND CAPACITIES UP TO 70,000 G.P.M.

For diversified, continuous duty services in industrial, chemical and process plants, etc. Peerless centrifugal pumps incorporate many proven design features for extended pump life, minimum down-time and operative economy.

GENERAL SERVICES
Peerless type A pumps afford top-flight, continuous duty operation with capacities from 50 to 70,000 g.p.m. Heads: 15 to 300 ft. All types of drives: 1 to 1000 h.p. Sizes: 2" to 42" discharge. Split-case, single stage, double suction type.

FIRE PUMPS
Peerless Underwriters' Approved fire pumps are available for all fire protection services. Capacities: 500 to 2000 g.p.m. Pressures: to 150 lbs.; single and double stage types, for electric, engine, turbine drive or combinations.

BOILER FEED
Peerless Type B multi-stage pumps are designed for boiler-feed, pipe line and refinery services delivering capacities up to 900 g.p.m. against pressures up to 700 lbs. For electric and other type drives from 60 to 350 h.p.

PROCESS SERVICES
Peerless Type DS is the ideal pump for chemical, oil, soap and similar process services. Capacities: 10 to 1500 g.p.m. Heads: up to 231 feet. Handles a wide variety of corrosive or non-corrosive liquids at temperatures to 200° F.; Single stage, single suction.

PEERLESS PUMP DIVISION
FOOD MACHINERY CORPORATION
Factories:
Indianapolis, Ind. • Quincy, Ill. • Los Angeles 31, Calif.
District Offices: Canton 2, Ohio; Philadelphia: Suburban Square, Ardmore, Pa.; Atlanta: Rutland Bldg., Decatur, Ga.; Dallas 1, Tex.; Los Angeles 31, Calif.

PEERLESS PUMPS
FOR MOST SERVICES IN ALL INDUSTRIES

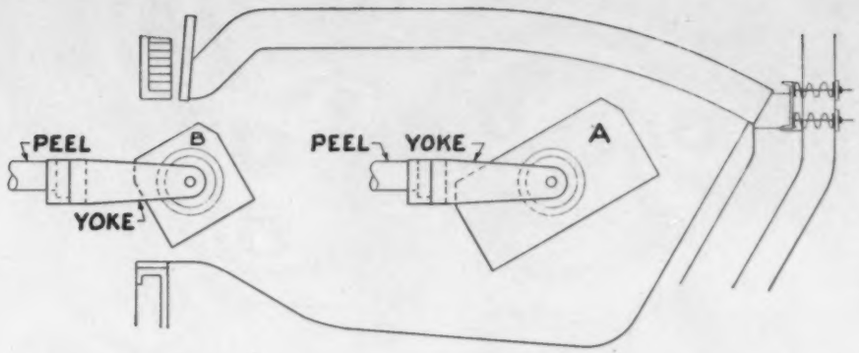


Figure 1 — This cross-sectional view of an open hearth furnace illustrates the clearance within the furnace available for the 180 cu ft charging box, and the 90 cu ft within the door opening.

how really large this box can be and what it will do to improve the existing scrap charging bottleneck.

The proposed 180 cu ft charging box would be about 6 ft 0 in. wide, 3 ft 0 in. deep, and 10 ft 0 in. long, so it could be handled on a conventional buggy — one box per buggy. Either the box or the conventional charging peel would be equipped with a forked type yoke to span its 10 ft 0 in. length. By means of a special drive, the box will be rotated within the support yoke so it swings towards the backwall; and, dumps the scrap ahead of the peel. Unloading the box in this manner will allow stacking the scrap ahead of the peel along the backwall instead of under the peel in the center of the furnace. Accordingly, the following boxes would not have to be entered and dumped over top of the preceding charges.

Figure 1 shows a cross sectional view of an open hearth furnace with this 180 cu ft rotating type box, marked A, being dumped along the backwall. The second box of scrap is then laid on the sloping face of the preceding one and so on for possibly three or four boxes. At this point, possibly, the lack of overhead clearance adjacent the doors would prevent swinging this 6 ft 0 in. wide box for dumping. Therefore, some 3 ft 0 in. wide boxes, marked B, which can be rotated within the 5 ft 0 in. height of door opening, could be used to finish off. This smaller box would be one-half the size of the large box and still have a capacity of 90 cu ft.

Lengthwise of the furnace, there would be five consecutive doors, each door about 6 ft 0 in. wide. A two-door opening adjacent the burner end would accommodate the "across the furnace" plan of charging described above. Then, the two doors at the other end of the furnace would be similarly charged. The middle door of the five, opposite the tap hole, could be charged by conventional boxes if necessary to get the total bulk of required scrap into the furnace.

If the furnace is long enough for six 6 ft 0 in. wide doors, then the schedule of charging can be set up for three "across the furnace" applications. Or a shorter furnace can be equipped with six doors of a narrower width and the charging boxes reduced

(*Please turn to page 140*)

BUT...

It would be obsolete now—when industry requires faster, more efficient, more economical methods than those of yesterday.

CHEMICALS ACP PROCESSES

RUST PROOFING AND PAINT BONDING
Granodine *
Duridine *
Alkodine *
Lithoform *
Thermoil-Granodine *

RUST REMOVING AND PREVENTING
Deoxidine *
Peroline *

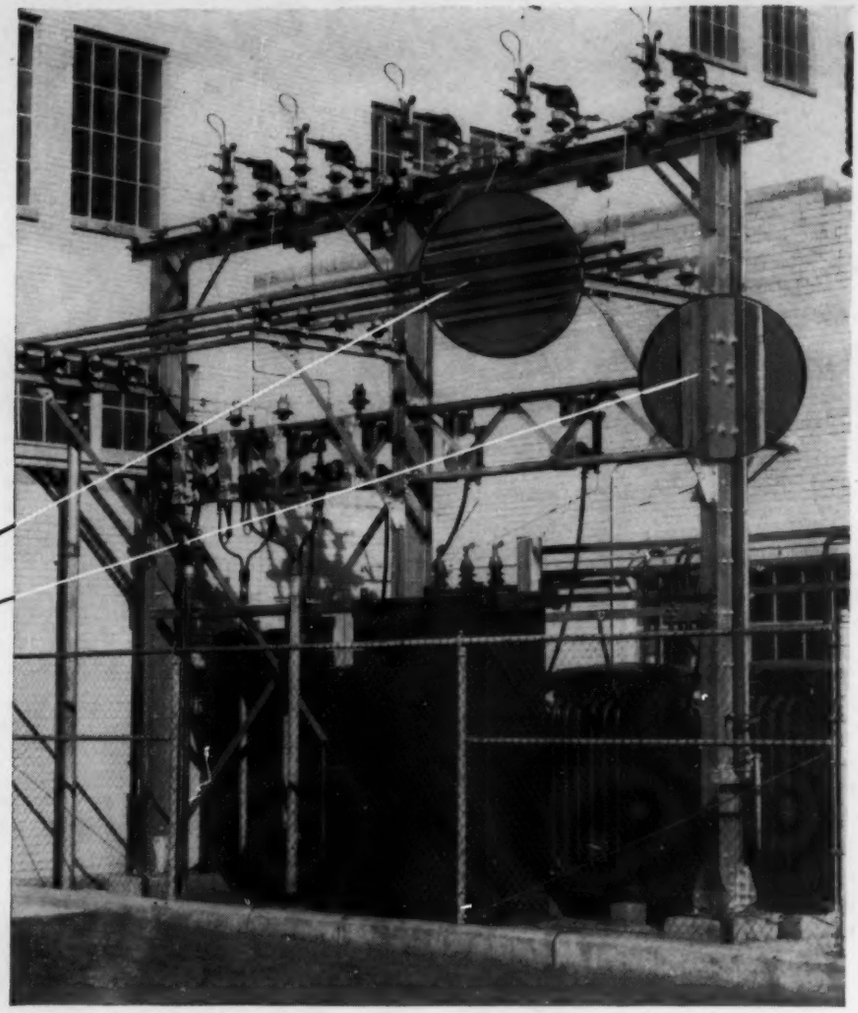
PICKLING ACID INHIBITORS
Rodine * ®

Cuprodine *

being fast, efficient, and economical, is a "natural" for modern wire mills. "CUPRODINE" lubricates—reduces scratching—prolonqs die life—increases linear footage of drawings per die—makes possible uniform drawing. Steel can be CUPRODIZED in a simple immersion process without electricity.

For passivating CUPRODIZED, or solid copper surfaces—and for bonding paint, specify "CUPRO-TEK"*.

AMERICAN CHEMICAL PAINT CO.
AMBLER ACP PENNA.



2 TWO KINDS OF ALCOA ALUMINUM FOR 2 TWO KINDS OF SUBSTATION SERVICE

The bus conductors are Alcoa Aluminum that has high electrical conductivity. Has greater current-carrying capacity *per pound* than any other kind of bus conductors. Weighs less per foot . . . is easily formed and gives the advantage of great structural stiffness.

The substation structure is high-strength Alcoa Aluminum Alloy*. The light weight of the members eliminates heavy erection equipment. An all-aluminum substation is easier and cheaper to fabricate and erect. Cannot rust, avoids the inconvenience and cost of painting.

When you are designing substations and switching stations, go Alcoa Aluminum all the way. Build the structures of strong, lightweight Alcoa Aluminum Alloy Shapes . . . then install high-efficiency Alcoa Aluminum Bus Conductors** to carry the current. ALUMINUM COMPANY OF AMERICA, 2128 Gulf Bldg., Pittsburgh 19, Penna. Sales offices in 55 leading cities.

*Alcoa 61S-T **Tubes, bars, shapes

MORE PEOPLE WANT MORE ALUMINUM FOR MORE USES THAN EVER

ALCOA FIRST IN ALUMINUM

IN EVERY COMMERCIAL FORM

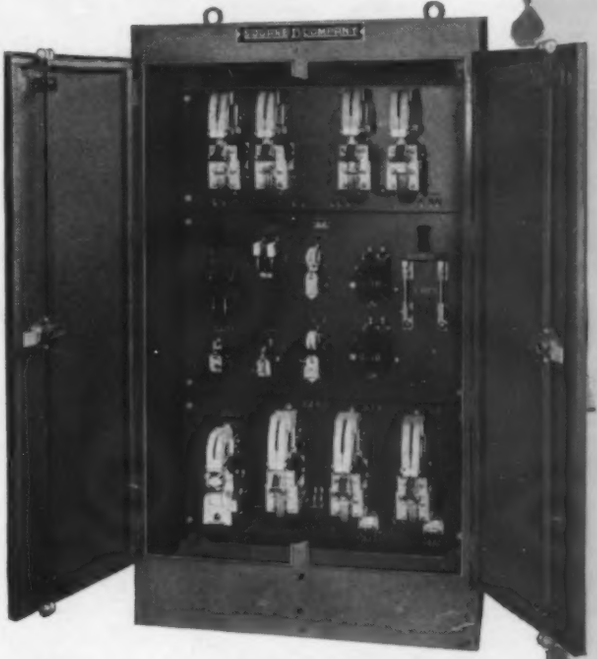
PERFORMANCE PLUS +

PART OF THE PARADE OF NEW DESIGNS

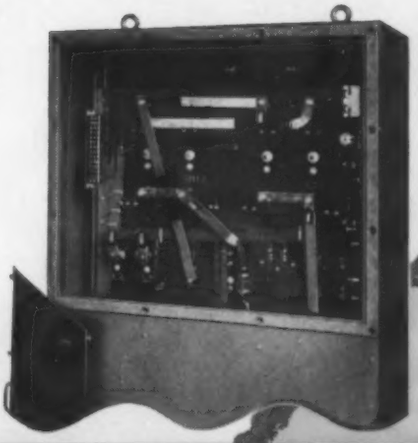
WITH SQUARE D HEAVY DUTY D. C. MILL CONTROL

• Performance of mill control is essential to insure uninterrupted production, but installation and maintenance requirements are important too. SQUARE D has recognized them with these design features . . .

- Sturdy enclosures available in NEMA Types 1, 1A and 4.
- Heavy eye-bolts fasten directly to panel frame for safe handling.
- Double-door enclosures eliminate door-opening problems.
- Vault-type, door-locking mechanism provides latching at top, bottom and center of each door. Rollers on latching bar eliminate friction.
- Flange on cabinet, combined with vault door mechanism, "bites" into gaskets for dust-tight seals.
- Center channel is removable to permit unobstructed access to control panel.
- All devices on panel are identified by ¾"-high letter marking.



- Patented fasteners on removable back plates save time and eliminate possibility of lost screws.
- Adequate wiring space above, below and in back of panel.
- Control terminals mounted on angle bracket for easy access in wiring.
- Discharge resistors and fuse clips for ballast-resistors mounted on common angle-bracket for convenience and ease of maintenance.
- Power terminals identified by ¾"-high letter marking.



***+ PLUS** important installation and maintenance advantages.*

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Personnel News . . . .

Irvin Paul has been made division superintendent of maintenance at the Gary sheet and tin division of Carnegie-Illinois Steel Corporation. Mr. Paul, who was born in Brunswick, Indiana, started his career at the Gary sheet and tin mill on March 15, 1918, as a machinist in the mechanical department. He advanced through various supervisory positions until September 1, 1937, when he was appointed superintendent of the 80 in. hot strip department, the job he has held until the present time.

Harry Y. McCool, Sr., superintendent of maintenance of Timken Roller Bearing Company's Steel and Tube division retired September 1, after more than 31 years of service. Mr. McCool, who was born in Perrysville, Ashland County, Ohio, joined the Timken firm in October, 1915. He was promoted to tube mill superintendent in 1920 and held that position until his promotion to superintendent of maintenance for the Steel and Tube division in 1938.

Leland S. Steiner was appointed superintendent of maintenance for Timken Roller Bearing Company's Steel and Tube division.

Mr. Steiner started with Timken Roller Bearing Company in June 1925, in the electrical department of the Steel and Tube division and was promoted to superintendent of the department on July 19, 1938. On February 16, 1945, Mr. Steiner received his promotion to assistant superintendent of maintenance.

David Lyle has joined Continental Foundry and Machine Company as assistant vice president in charge of engineering and will be located in the Pittsburgh office in the Grant Building. His more than 20 years of engineering experience have been largely spent in the steel and allied industries and, until recently, he was engineer of roll and mill department at the Mesta Machine Company. Mr. Lyle studied mechanical engineering at Carnegie Institute of Technology. His background of experience includes Wisconsin Steel works of International-Harvester, Western Cartridge Company, Koppers Company and Carnegie-Illinois Steel Corporation.

John L. Peet, division superintendent of maintenance at Carnegie-Illinois Steel Corporation's Gary sheet and tin mill, retired August 31 due to ill health. Another native Hoosier, Mr. Peet was born at Jeffersonville, Indiana. He received his Bachelor of Science degree in civil engineering from Valparaiso University. On November 27, 1915, he was employed as foreman in the tin mill machine shop. He has held various supervisory positions at the tin mill as well as serving five years as assistant chief civil engineer at the National Tube Company plant in Gary, another U. S. Steel subsidiary. When the sheet and tin mills were combined in 1936 into one mill, Mr. Peet was appointed to his present position as division superintendent of maintenance.

C. F. Gross has been appointed Philadelphia division manager for the C and D Battery Company. The C and D Philadelphia division organization handle the sales of the complete C and D industrial battery line. Mr. Gross was educated at the Drexel Institute of Technology, Philadelphia. He was formerly with the Philco Storage Battery Corporation, which was recently bought out by Gould Storage Battery Company of Depew, New York, a subsidiary of National Battery Company.

Thomas S. Wilmeth has been named assistant production control manager of Allis-Chalmers general machinery, West Allis works. He succeeds **R. L. Bruesewitz,** resigned.

Mr. Wilmeth, who holds a bachelor of science degree in electrical engineering from Purdue University, has been with Allis-Chalmers since January 1936, during which time he has worked in the erection and engineering departments as well as the company's Boston, Pittsburgh and Norwood works. From 1938 to 1942 he served as sales engineer in Allis-Chalmers Bluefield, West Virginia, office. Recently he had been assistant superintendent of material control.

IRVIN PAUL

LELAND S. STEINER

DAVID LYLE

James D. Kelly, a member of the staff of the Association of Iron and Steel Engineers since 1930, has resigned to establish his own private publishing business. Mr. Kelly was advertising and business manager

JAMES D. KELLY

of the *Iron and Steel Engineer*, and, with the exception of two years in the U. S. Navy during World War II, spent his entire business career with the Association.

H. M. Griffith, until recently general superintendent, of the Hamilton and Ontario works of Steel Company of Canada, Ltd., becomes works manager of these plants. Mr. Griffith joined the company as a metallurgist in 1936, subsequently occupying the positions of open hearth superintendent, assistant works manager and general superintendent.

Henry Coughlin, superintendent of transportation and labor, Chicago district, Republic Steel Corporation, has been appointed chairman of the corporation's transportation committee. He will succeed **George Hackett,** superintendent of transportation for Republic in the Youngstown district.

James E. Smith was appointed open hearth superintendent of Republic Steel Corporation's Cleveland district plant. Mr. Smith, a native Clevelander, graduated from John Carroll University and attended Case Institute of Technology. In 1917 while still in college he started to work in the open hearth department at the Corrigan-McKinney Steel Company. He continued with Republic after the 1935 merger and has been connected with the open hearth department ever since. He succeeds **Harry L. Allen, Jr.,** who has been transferred to Republic's Buffalo district as assistant district manager.

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BREA, CALIFORNIA
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Houston 1

From a 1900 Code Book, an Okonite tape customer, Mr. R. J. McGinnis, tore out the advertisement shown (below at left) and sent it to us. Mr. McGinnis, of the Electric Service department of a large state university in the Midwest, wrote us that "the attached sheet will be of interest to your associates, especially the oldsters. It just goes to prove that a fine piece of quality merchandise lives on its merits and the service it delivers. Price is forgotten but quality remains for many years. Okonite and Manson Tapes have been on our shelves and in use on the campus for years. Needless to say, we expect to continue its use for a very good reason."

To this, we at Okonite have little to add other than showing a recent advertisement "Submerged for 13 Years and Still Good." We show this not so much for contrast as to give evidence that we are not taking leadership for granted but are making every effort to increase the service life expectancy of Okonite and Manson Tapes, which are described in Bulletin OK-1007, a copy of which is yours for the writing. The Okonite Company, Passaic, New Jersey.

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SUBMERGED FOR 13 YEARS AND STILL GOOD!
...isn't this the kind of splice you'd like to make?
This photograph shows one of several splices protected with Okonite and Manson Tapes after removal from test following 13 years immersion in water.
The story of this long-time test explains the confidence placed by electrical men in Okonite and Manson Tapes especially for splicing and tapping underground cables installed in wet locations – such as non-leaded rubber-insulated network cables and power feeders.
Each year all of these splices, made on 4/0 Okoheath 600-volt network cable, withstood a test at 7000 volts a-c for five minutes. Insulation resistance readings were still in excess of 370,000 megohms when the splices were removed for examination. Such prolonged immersion had not affected the electrical strength.
Dissection showed that the Okonite splicing compound was securely bonded to the connector and conductors and had become vulcanized into a firm homogeneous seal that not one drop of water had penetrated. That's why so many experienced users say that for long, trouble-free service there's nothing like Okonite Rubber and Manson Friction Tape for splicing rubber-insulated cables.
We'd like to show you how easy it is to make joints like these. Just drop us a note on your company letterhead and ask for Bulletin OK-1007 and samples of these high-grade splicing tapes. The Okonite Company, Passaic, N. J.
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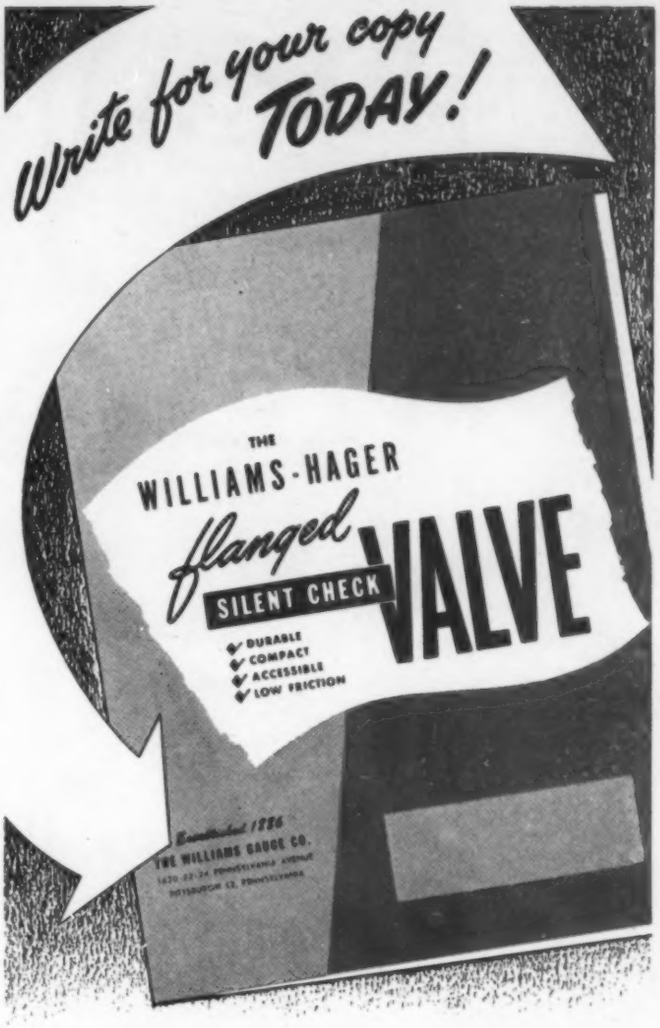

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Dr. Maxwell Gensamer has been appointed assistant to director of research of Carnegie-Illinois Steel Corporation. Dr. Gensamer, a graduate in metallurgy from Carnegie Institute of Technology, received his master's degree in metallurgy and doctor's degree in science from the same institution. He served five years as plant metallurgist for the Page Steel and Wire divi-

MAXWELL GENSAMER

sion of American Chain and Cable Company, returning to Carnegie Tech in 1929. Subsequently he held positions there as assistant professor and associate professor of metallurgy, becoming a full professor in 1943.

In 1945 Dr. Gensamer joined the staff of Pennsylvania State College as professor of metallurgy and head of the department of mineral technology, the position he held until his present appointment with Carnegie-Illinois.

Arthur A. Kappenhagen was appointed assistant open hearth superintendent at the Cleveland district plant of Republic Steel Corporation. Mr. Kappenhagen has been connected with Republic and Corrigan-McKinney since 1934. He was raised in Cleveland, graduated from Cathedral Latin High School and attended Fenn College and Case Institute. He was assistant superintendent of the general labor department before coming to the open hearth department in 1943.

William E. Clark, general manager of Dravo Corporation's Keystone division has been elected a vice president. Mr. Clark was graduated from Ohio State University in 1921. Following three years with an American firm in Mexico, Mr. Clark joined the Lehigh Portland Cement Company, and was manager of its Pittsburgh office until 1930, when he was appointed assistant to the manager of the Keystone Sand and Supply Company, Pittsburgh, one of the pioneer Dravo companies. In 1937 Mr. Clark became president of Miller and Coulson Company, Pittsburgh wholesale construction materials firm. He later acquired control of the company and operated it as the W. E. Clark Company. This company was merged with the Keystone division in 1945, and its activities continue under the Keystone name. Mr. Clark was appointed assistant to the vice president of Dravo's Wilmington, Delaware shipyard in 1942, and in 1944 was appointed administrative manager. On June 1, 1945, Mr. Clark was trans-

ferred to Pittsburgh as general manager of the Keystone division. In 1946 he was elected a member of the board of directors of Dravo.

J. M. Nelson has been made chairman of the blast furnaces, the open hearth and the coke committee of American Steel and Wire Company. Mr. Nelson's first association with U. S. Steel Corporation was in June 1908, when he started as a mine shaft boss with the Oliver Iron Mining Company. In October 1913, he became a timekeeper with the Minnesota Steel Company, which since has become part of American Steel and Wire. He remained in Duluth until October 1937, when he left the position of superintendent of open hearths to go to Donora. Since May 1945, he has been division superintendent of open hearths at the Donora Steel and Wire plant.

William C. Krecklow, who started with Allis-Chalmers in 1910 as an office boy, has been named production control manager of the company's West Allis general machinery works. In his more than 30 years with Allis-Chalmers, Mr. Krecklow has successively been a flour milling draftsman, motor winder, switchboard and switchgear foreman, assistant superintendent, superintendent of production schedules and of the electrical manufacturing division. Mr. Krecklow is succeeded as electrical manufacturing division superintendent by **Arthur A. Ryan,** who has been serving as general foreman in the company's electrical shops.

J. C. Witherspoon has been appointed division superintendent of open hearths at the Donora, Pennsylvania, Steel and Wire works of American Steel and Wire Company. Mr. Witherspoon returns to the plant where he first started for the wire company and where he had many years of service. He began in April 1916, as a second helper in the open hearth department. He progressed through the ranks until he was named assistant general superintendent of the Donora Steel and Wire works, before being transferred in August 1940, to the Duluth works as general superintendent of the steel plant. In August 1945, he was transferred to Cleveland as chairman of the blast furnaces, open hearth and coke committees, which position he now relinquishes to assume his new duties.

G. P. McAleer, formerly assistant general superintendent, has been appointed assistant works manager, Hamilton and Ontario works of Steel Company of Canada, Ltd.

J. H. Thompson, superintendent of the coke and by-products plant at the Fontana steel mill of Kaiser Company, Inc., resigned to accept a position with an eastern steel company.

Clarence R. Lohrey, formerly assistant superintendent of the coke and by-products plant, has been appointed superintendent of that plant at the Fontana steel mill of Kaiser Company, Inc.

E. B. Cleborne, vice president and director of Allegheny Ludlum Steel Corporation, was elected executive vice president of the corporation by the board of directors. Mr. Cleborne has been a vice president and director of the corporation since Allegheny Steel and Ludlum Steel merged in 1938. Prior to that he was a

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vice president and director of Ludlum Steel Corporation.

He is also president of the Wallingford Steel Company, Wallingford, Connecticut, a subsidiary company of Allegheny Ludlum, and will continue in that position.

Connected with the iron and steel industry since 1914,

E. B. CLEBORNE

Mr. Cleborne's first position was with the Worcester, Massachusetts, Pressed Steel Company. He later was affiliated with the American Tube and Stamping Company until 1921, when he left to organize and build the Wallingford Steel Company. He was made its president in 1925.

T. E. McDowell has been elected vice president in charge of engineering for Pyle-National Company, Chicago, Illinois. Mr. McDowell has been chief engineer in charge of product design since 1930. After graduating

T. E. McDOWEL

from the Illinois Institute of Technology he served a brief period with the Illinois Bell Telephone Company, then joined the Pyle-National Company, in 1935, as an electrical engineer. Mr. McDowell is a registered professional engineer.

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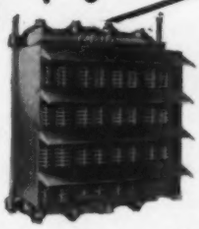

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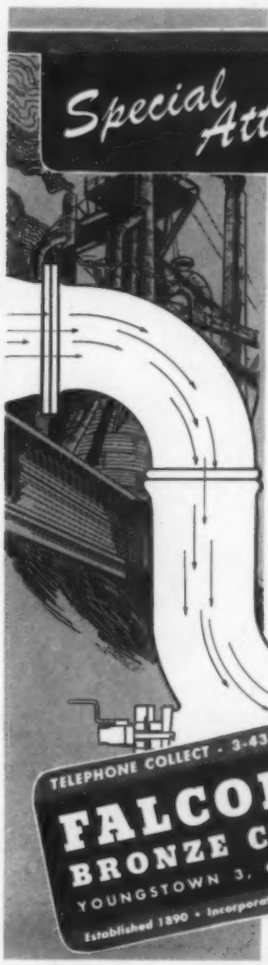

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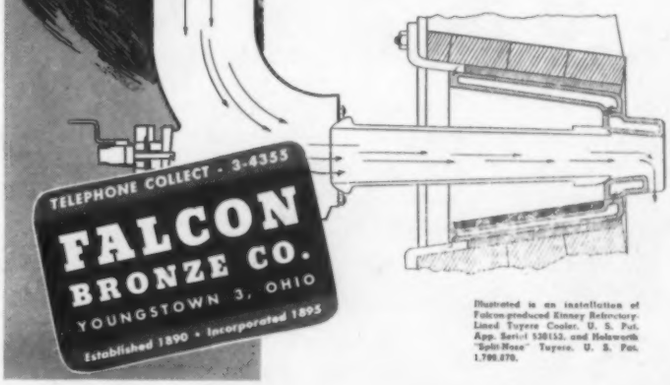

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(*Continued from page 129*)
in length to fit the then available two-door width.

Let's take a typical example of an open hearth furnace which charges 100,000 lb scrap per heat by means of 18 cu ft charging boxes and four boxes per buggy. Each buggy carries about 4400 lb of scrap, which is 1100 lb per box, or an average of 61 lb per cu ft. The total charge requires 91 boxes per heat.

The proposed 180 cu ft box would fit one of these buggies and at 61 lb per cu ft would carry about 11,000 lb. Accordingly, nine such boxes would furnish 99,000 lb which is short 1000 lb of the required amount. Any such deficiency could be made up by adding one or more conventional charging boxes.

Since this is a rather small furnace, and can only accommodate five consecutive doors, it will take two "across the furnace" scrap applications. Four 180 cu ft boxes and one 90 cu ft box would be applied to each end. If only three large boxes can be charged due to the overhead clearance, then it would take three 180 cu ft boxes and three 90 cu ft boxes at each end. From the charging machine viewpoint, it would still only be twelve boxes or operations as compared with the 91 operations on the conventional 18 cu ft boxes.

Naturally, if a heavier grade of scrap is used in a box of 180 cu ft size, it would have to be loaded per weight in order to keep within the lifting capacity of the charger. Likewise, if a very light scrap is used, the above example would have to be corrected to include the added number of boxes required. One thing sure, any scrap deposited by a magnet into a box with an opening of 6 ft 0 in. × 10 ft 0 in. would sure enough be in the box and not a good part of it hanging on the sides and top edges, as is typical of a small 18 cu ft box.

Book Reviews

▲ An entire new listing of its 874 standards is now available free of charge at the American Standards Association and may be obtained from their office, 70 East 45th Street, New York 17, New York.

The new listing of American Standards includes prices which are revised slightly upward, because of increased production cost. A number of additional revised standards approved since the January 1947 issue of all American Standards are included.

Under the new price listing a complete set of all American Standards comes to $200.00 and a complete set of all American Safety Standards costs $32.50 a set.

Customary quantity discounts are allowed in the new catalogue. These range from 20 per cent to 45 per cent for various quantities up to 1000.

The foreword to the catalogue says:

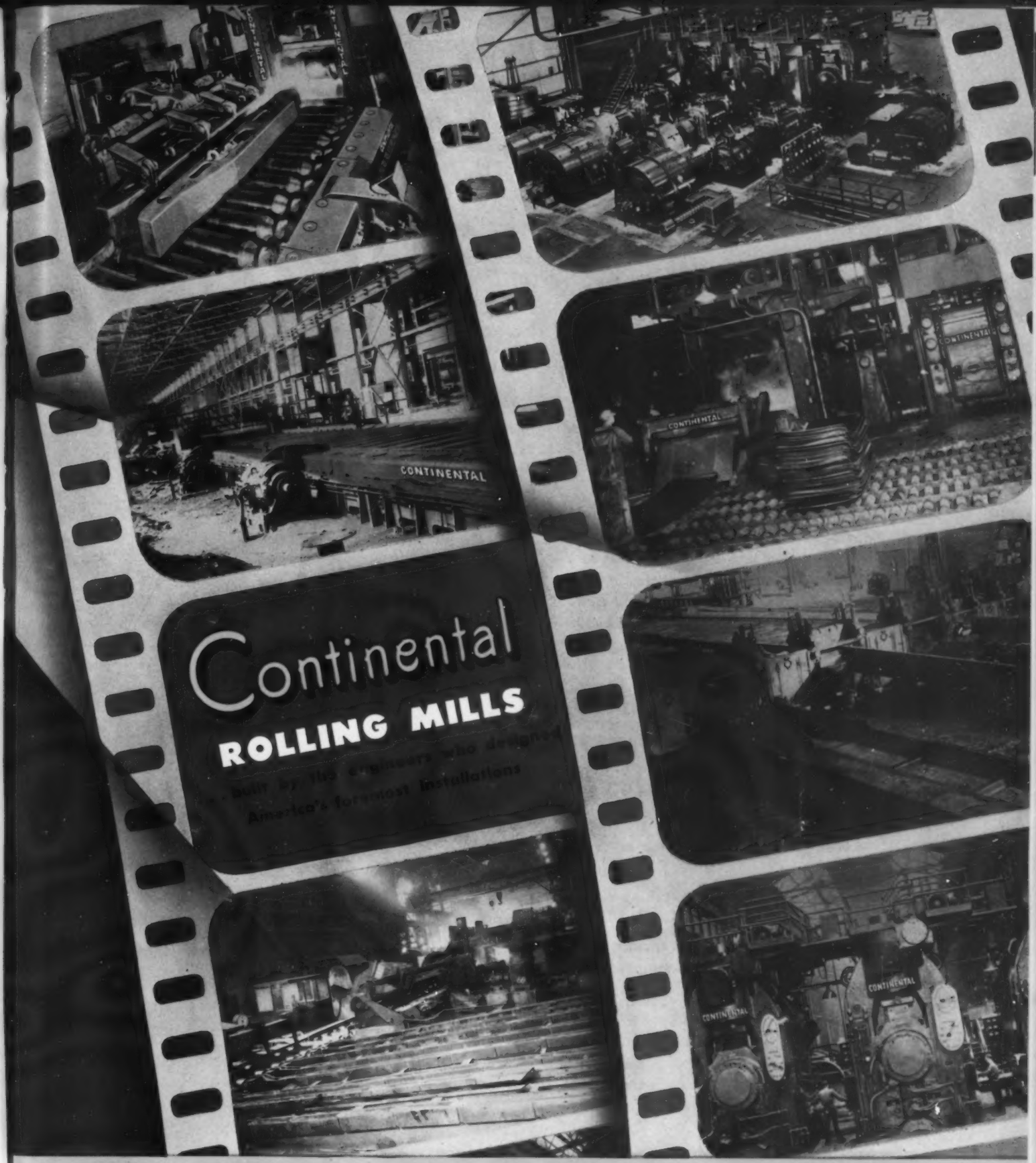
"These standards are used throughout industry and by municipal, state, and federal governments. Manufacturers use them to facilitate production operations or lower production costs, or to eliminate controversies between buyer and seller, or to raise the level of their industry by eliminating misrepresentation—consumer groups, as a yardstick to measure the merit of the things they buy — government agencies, in their capacity as buyers or as protectors of the public interest."

▲ A "Symposium on Atmospheric Weathering of Corrosion-Resistant Steels," presented at the 1946 ASTM annual meeting is intended to give in convenient form an up-to-date picture, based on the latest data, of the behavior of the so-called stainless steels when exposed to the atmosphere. The publication incorporates a great amount of information and data that have been developed not only under the auspices of ASTM Committee A-10 on Iron-Chromium-Nickel Alloys but by leading organizations concerned with the problem. Subjects covered include: Atmospheric Corrosion Tests on High-Chromium Steels — W. O. Binder and C. M. Brown, Union Carbide and Carbon Research Laboratories, Inc.; Corrosion-Resistant Steel for Architectural and Structural Applications — H. A. Grove, Central Alloy District, Republic Steel Corporation; Atmospheric Corrosion Tests of Corrosion-Resistant Steel Wires — A. P. Jahn, Bell Telephone Laboratories; Corrosion-Resistant Steel Sheet in Marine Atmospheres — Willard Mutchier, National Bureau of Standards. Also covered by authorities in their field are the following: Atmospheric Corrosion Tests on Corrosion-Resistant Steel — Grant L. Snair, Jr., Allegheny-Ludlum Steel Corporation; Weathering Behavior of Corrosion-Resistant Steel Insect Screens — W. A. Wesley and H. R. Copson, The International Nickel Company, Inc.; Results of 15 Years' Exposure Tests on Corrosion-Resistant Steels — I. V. Williams and K. G. Compton, Bell Telephone Laboratories. Copies of this 92 page publication, heavy paper cover, can be obtained from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pennsylvania, at $1.50 per copy.

▲ "Compressed Air Handbook," first edition, published by Compressed Air and Gas Institute, New York, New York, 400 pages, 6 × 9 in., 247 illustrations, including photos and drawings; stiff-backed, simulated leather cover, gold embossed; price, postpaid, anywhere in United States, $3.00 per copy; elsewhere $3.50. "Compressed Air Handbook" is published to meet widespread demands for a reference text on applications, installation, operation and maintenance of compressing equipment and air-powered tools of all types. In addition to making available a mass of new and original data not heretofore published in a single volume, the handbook contains, in revised and improved form, all of the standard reference material formerly published as "Trade Standards." Included are definitions, test standards and numerous basic tables and formulae.

The object in editing "Compressed Air Handbook" was to provide a comprehensive volume of reference data which would meet technical and engineering needs and, at the same time, serve the layman and student with information on the wide versatility, flexibility and utility of modern compressed air power.

▲ Through the work of its Committee B-4 on Electrical-Heating, Resistance and Related Alloys, the American Society for Testing Materials has issued an original Bibliography on Electrical Contacts and three supplements. The 1946 supplement became available in August 1947, carrying a June printing date. The latest 26 page supplement gives replacements and new references for 1940-1944 and covers publications in 1945 and 1946. This third supplement, 6 by 9 in., heavy paper cover, can be procured from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pa., at 75 cents per copy. The original Bibliography with 148 pages is available at $5.00, cloth binding, and the first and second supplements at $2.00 per copy and 50 cents per copy, respectively. The original Bibliography with all three supplements is $6.50.



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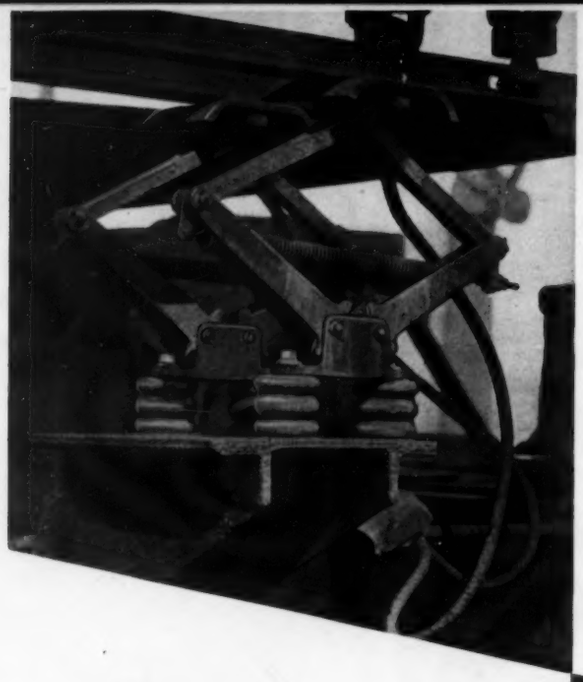

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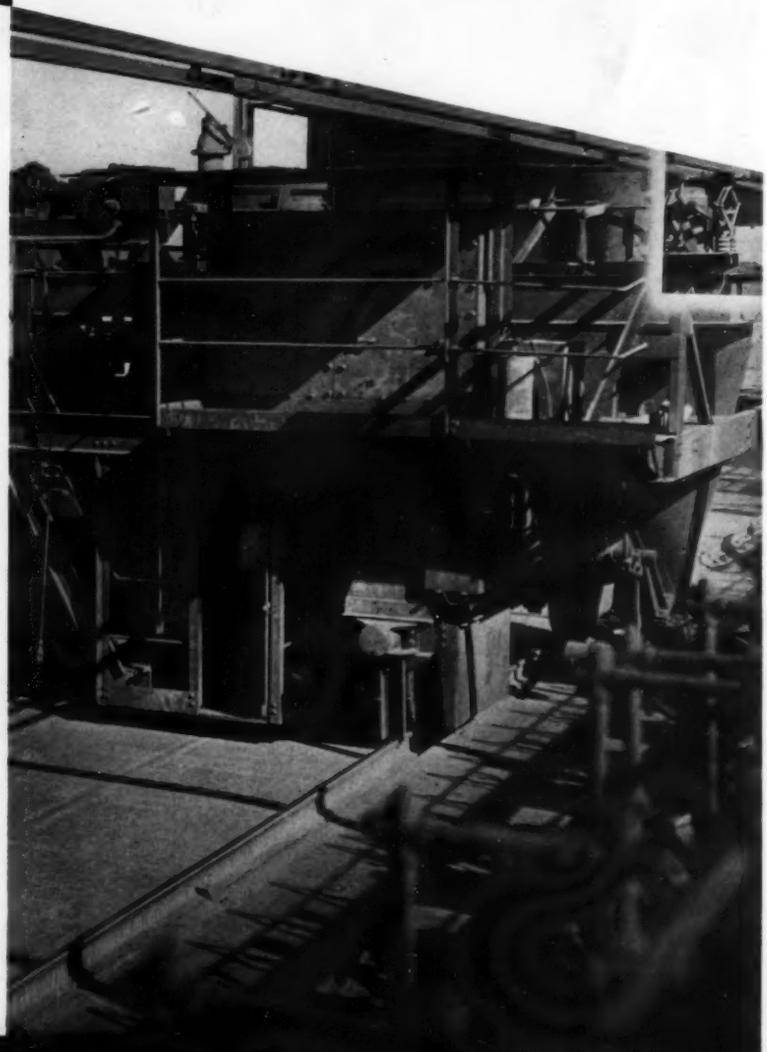
Keystone Universal Current Collectors are standard equipment in many of the nation's leading industrial plants. They are so designed and manufactured as to maintain positive contact under unfavorable conditions created by snow, sleet and dirt and the improper alignment of the conductor.

Keystone Universal Collectors are everything their name implies—they are a combination of parts which offer the following variations:

- **Insulated or non-insulated mounting**
- **For mounting on horizontal or vertical surfaces**
- **With swivel or rigid base**
- **With wheel or shoe forms of contact units**
- **With shoe contact units hinged, or hinged and swiveled**
- **With optional contact members suitable for all forms of conductors**

Whatever your need . . . wherever your installation Keystone has the answer to assure safe, sure contacts at all times. Write today for the catalog telling about these and many other Keystone Products for industry.



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You get better service longer...

from furnaces lined with adaptable REFRACTORY CONCRETE

Adaptability of design is a time-saving and cost-saving feature of Refractory Concrete—the special concrete made with Lumnite and refractory aggregates.

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For descriptive booklet, "REFRACTORY CONCRETE," write: LUMNITE DIVISION, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, New York.

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LUMNITE FOR REFRACTORY CONCRETE

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CHECK THESE HIBAY ADVANTAGES

1. These units are equipped with Hi-Stress* (special heat-and-shock-resisting) prismatic glass reflectors.
2. An aluminum cover is permanently spun over external prisms using a mastic seal at the joints.
3. Five different prismatic reflectors offer exact lighting pattern required.
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5. Prismatic glass surfaces are impervious to chemical action from fumes or soot.
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7. Tripod holder and ring grip reflector to assure exact positioning of lamp.
8. Outside socket construction favors trouble-free lamp burning.
9. Steel parts plated to resist corrosion.

Send for data sheet giving full optical and mechanical information for the entire line of HIBAY equipment.

*Reg. U. S. Pat. Off.

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THE HOLOPHANE COMPANY, LTD., THE QUEENSWAY, TORONTO 14, ONTARIO

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If you have a department where corrosive or dangerous fumes require constant removal, you can increase production by installation of an exhauster which will STAY ON THE JOB!

Above: This large Buffalo Rubber-lined Exhauster is handling fumes in a glass-etching factory.

Right: Small Buffalo Rubber-lined Exhauster with side plate and rotor removed. Note how smooth rubber-coating covers every part of housing.

Buffalo Rubber-lined Exhausters give from 3 to 13 times as much service as metal fans, on corrosive fume jobs. The rotor and entire inside of housing is coated with rubber by the exclusive B. F. Goodrich "Vulcalock" process. Fumes cannot come in contact with metal. And — an important consideration—you get the efficient performance of a "Buffalo" fan — designed for the service.

Thousands of these fans now in service have added hundreds of thousands of hours of production. Write for Bulletin RL for details.

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Speer knows brushes—the operating conditions for which each grade is best suited. Speer also knows motor and generator characteristics. With this 50-year combination of experience, Speer is highly qualified in matching brushes to machinery, mechanically and electrically, to deliver peak commutating performance.

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on Open Gear Lubrication for Large Eastern Steel Plant

it's almost unbelievable...

These are the kind of tests Brooks Engineers welcome—for a thirty-day period each application of the previous lubricant was carefully weighed before application and positive reports filed. Then, for a thirty-day period Brooks Klingfast Special was given the same exhaustive tests, with these results:

- The initial cost of *Klingfast Special* was about 20% less than the previous lubricant used.
- Klingfast Special required only one-half the amount per application.
- Each application provided safe protection longer by 4 times.
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- Similar results are being reported by cement plants, aluminum plants, underground and strip mine operations and many other industries.

As a result of this amazing performance *Klingfast Special* has been made the standard specification for a number of plants owned by this firm.

PHONE, WIRE OR WRITE FOR COMPLETE TECHNICAL INFORMATION ON HOW SAVINGS LIKE THIS CAN BE MADE IN YOUR PLANT

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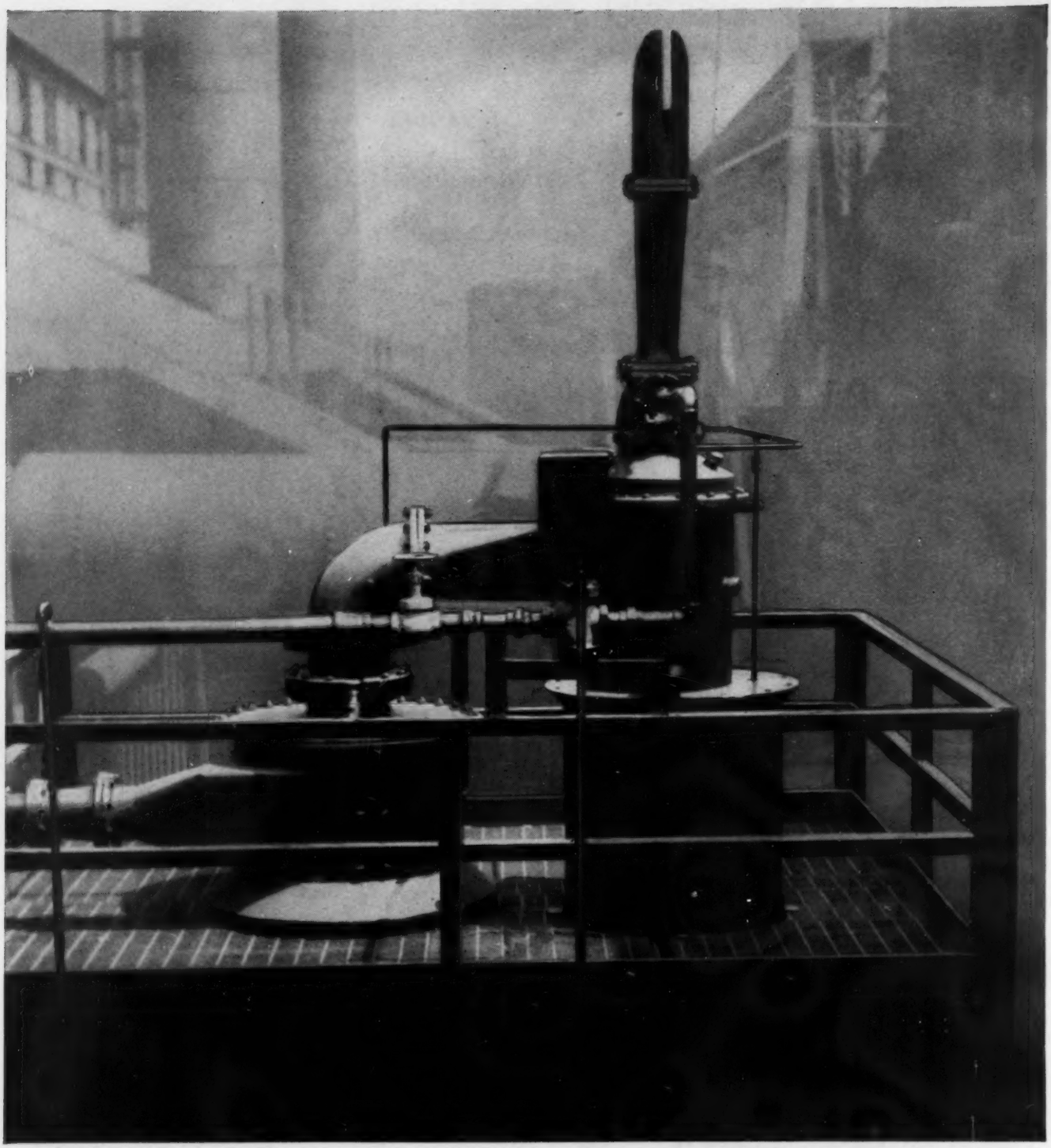
PRODUCTS OF ENGINEERING AND RESEARCH ON THE DIFFICULT LUBRICATION JOBS OF INDUSTRY SINCE 1876



ONE OF TWO LARGE STEAM VACU-UNITS

Showing one of two Model 106-X-S Steam-Vacu Units recently installed in a twelve furnace open hearth shop in the Youngstown, Ohio District by us.

THE VACUUM CONVEYOR COMPANY

MAIN OFFICES: CURREN ARCADE BUILDING, NORRISTOWN, PENNA.

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AN OIL SEAL as Simple as A B C

RIGID HEEL

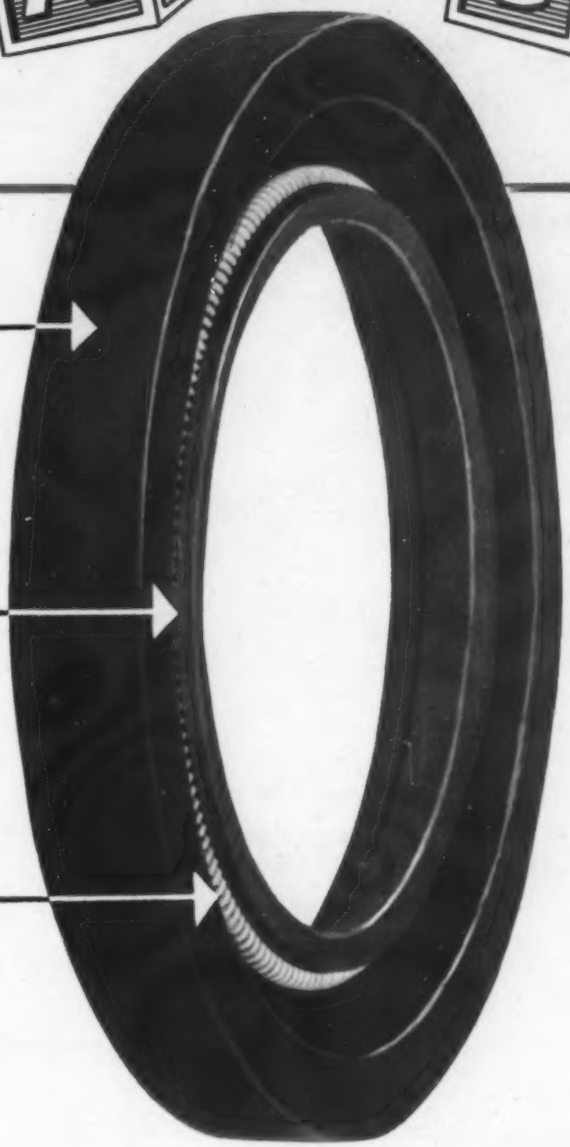
provides a positive press fit in the cavity, assuring a leakproof seal at this point.

FLEXIBLE LIP

an integral part of the seal, is available in a variety of designs to meet a wide range of conditions.

GARTER SPRING

controls lip pressure to provide most effective sealing and maximum seal life.



• The J-M Clipper Seal has all the virtues of simplicity—plus the practical advantages of superior bearing protection, longer life and ease of installation and removal which only an oil seal of its unique design can provide.

Consisting only of a moulded one-piece body and a garter spring, the Clipper Seal has no metal case. This permits greater bore tolerances. The relatively dense, rigid heel, designed for a press fit in the packing recess, eliminates the need for a cover plate for pressures under 5 psi. The tough, flexible lip is held in light but firm contact with the shaft by the garter spring which causes it to seal with a minimum of friction and wear.

Clipper Seals are recommended for packing against oil, grease, water, air, grit and coolants at temperatures up to 225 F. They are available in sizes from ⅝" diameter up.

For further details, write Johns-Manville, Box 290, New York 16, N. Y.

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Johns-Manville **PACKINGS & GASKETS**

These Bearings Pamper Roll Necks

Tough, Smooth Ryertex Cuts Maintenance, Reduces Costs

What pleases an operating man? In these days of high costs, a bearing that "babys" roll necks is to the point. And Ryertex bearings do just that. They cradle the roll in a smooth, tough plastic that reduces costs by prolonging equipment life.

Because of extremely low friction with water lubrication, Ryertex bearings run cooler—so cool that they completely eliminate fire cracking on the roll neck and fillet. In fact, the roll neck surface actually improves with use as the Ryertex polishes it to shining smoothness. The result—rolls equipped with Ryertex bearings last longer.

And the bearings themselves last longer, too. High strength with low friction reduces the number of bearing changes. Another economy—when replacements *are* necessary, practical Ryertex design eliminates expensive machine shop time. You just slip in new Ryertex liners and you're rolling again. It all adds up to lower bearing cost per ton of steel.

Ryertex bearings have proved their economy by performance on every type of mill: blooming mills, structural and bar mills, continuous mills, etc. If you're not yet rolling on Ryertex, let our engineers show you how Ryertex can take on the toughest jobs and still develop substantial savings. Write to:

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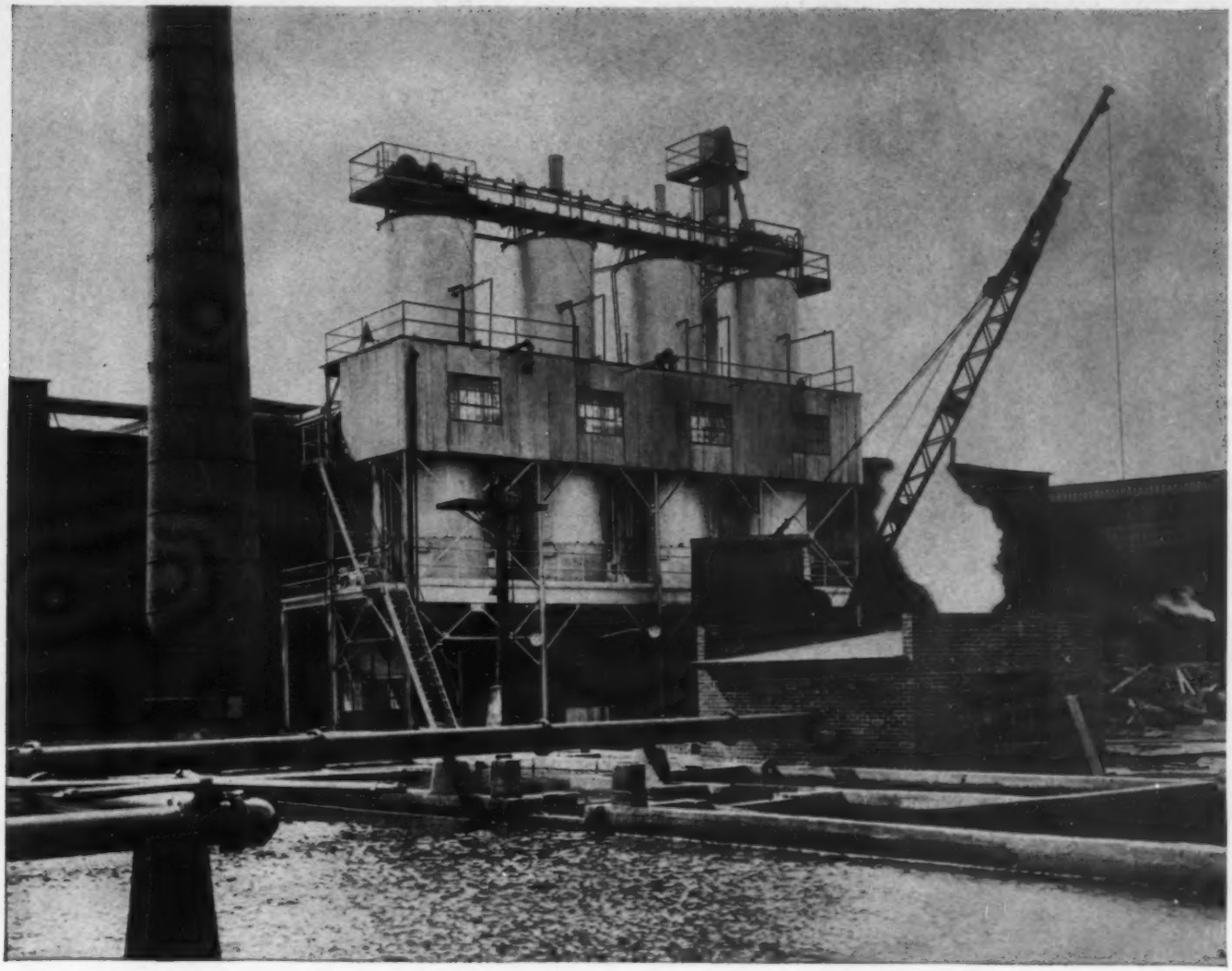

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WELLMAN WILL BUILD IT!

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- Gas Reversing Valves
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- Mine Hoists
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FUEL costs are usually lower when there's a Wellman-Galusha Generator on the job. It delivers a clean, dependable and uniform supply of gas in quantities and with characteristics to suit your individual requirements.

This gas can be used for all furnaces and kilns in the manufacture of ceramic ware, for chemical processes requiring special composition, and for all heating requirements in the manufacture of steel and non-ferrous metals.

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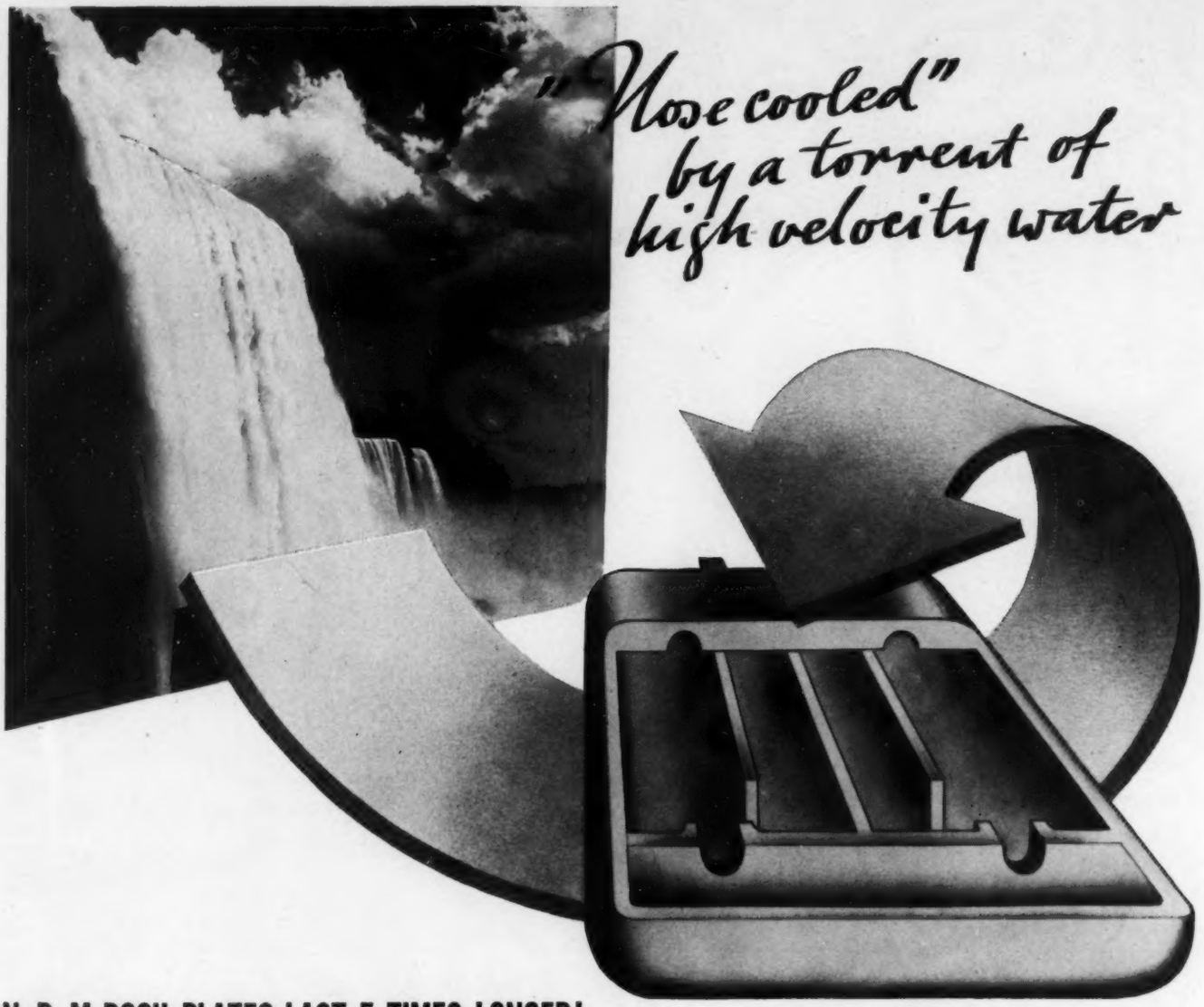

N-B-M BOSH PLATES LAST 5 TIMES LONGER!

By actual test our special double-compartment design (which delivers cold water directly to the nose) is so resistant to fire cracks and water leaks that it outlasts conventional plates 5 to 1.

- **Faster, more efficient cooling**
- **No sediment accumulation to block flow**
- **Second compartment can still be used for cooling, should nose finally crack**
- **Furnished ready to install, complete with pipes**

Next time, install N-B-M Bosh Plates and compare performance with your present type.

N-B-M BOSH PLATES
BRONZE AND COPPER CASTINGS

Blast Furnace Copper Castings • Roll Neck Bearings • Slippers Housing Nuts • Machinery Castings • Babbitt Metals • Acid Resisting Castings • Phosphorized Copper

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FOR TROUBLE-FREE WIRE PERFORMANCE

125 Permanently Insulated ROCKBESTOS Wires, Cables and Cords

From the three basic designs illustrated Rockbestos has developed a complete line of 125 failure resisting wires, cables and cords, a few of which are described. All have the same performance guaranteeing characteristics detailed below. Write for information or samples.

Rockbestos Permanent Insulation Insures Long-Lived Service

1. A tough impregnated asbestos braid, resistant to heat, flame, moisture, oil, grease, alkalies and corrosive fumes.
2. Felted asbestos insulation impregnated with heat, flame and moisture resisting compounds will not dry out with age, burn, or bake brittle under high temperatures.
3. Lubricated varnished cambric for high dielectric strength and added moisture resistance — protected from heat, flame and oxidation by felted asbestos walls.
4. Impregnated asbestos insulation that withstands heat of overloads and aging and won't become brittle, crack, rot or burn.
5. Conductors are perfectly centered in helically applied non-flowing insulation and will always remain so.

ROCKBESTOS 300 VOLT HEAT RESISTING FIXTURE WIRE
(Underwriters' Type AF)
Sizes No. 10 to 18 AWG stranded plain copper conductor insulated with black or white impregnated felted asbestos—with or without braid.

Rockbestos asbestos insulated fixture wires, approved by the Underwriters' Laboratories for lighting fixture wiring, will not bake out under the high socket temperatures developed in modern high-wattage fixtures. Also used for small motor and apparatus leads, switchboards, etc.

ROCKBESTOS A.V.C. 600 VOLT SWITCHBOARD WIRE
(National Electrical Code, Type AVB)
Sizes No. 18 to No. 4/0 AWG with varnished cambric and impregnated asbestos insulation and gray, black, white or colored flameproof braid.

Combine fire insurance and fine appearance in your switchboards with flame and heat resistant Rockbestos A.V.C. Switchboard Wire. Takes right angle bends without cracking because asbestos wall acts as a cushion beneath braid. Rockbestos A.V.C. Hinge and Switchboard Bus cables have same characteristics.

ROCKBESTOS A.V.C. 600 VOLT POWER CABLE
(National Electrical Code, Type AVA)
Sizes No. 18 AWG to 2,000,000 CM insulated with laminated felted asbestos, varnished cambric, and asbestos braid. Other constructions for service voltages to 5000.

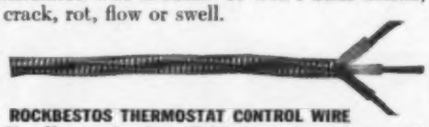
This cable is recommended for power leads of heat-exposed equipment and circuits that run near boilers, steam lines, furnaces, kilns and other hot spots. It withstands high ambient and conductor temperatures and has ample moisture resistance.

ROCKBESTOS A.V.C. 600 VOLT CONTROL CABLE
In one to 19 conductors with individuals insulated like Motor Lead Cable, cotton braid covered and cabled with an asbestos braid over all. Standard strandings AWG No. 12—19/#25 and No. 9—19/#22. Other strandings on order.

Designed for applications requiring a multi-conductor control cable capable of withstanding high temperatures, corrosive fumes, oil, grease and moisture. It also eliminates fire hazard as it will not burn. Used by equipment manufacturers, power companies, steel mills.

ROCKBESTOS A.V.C. 600 VOLT BOILER ROOM WIRE
(National Electrical Code, Type AVA)
Sizes No. 18 to 8 AWG insulated with varnished cambric, impregnated felted asbestos and asbestos braid. Sizes 6 to 4/0 have another wall of felted asbestos next to the conductor.

For lighting and control circuits exposed to heat and moisture, oil, grease, corrosive fumes or fire hazard around furnaces, ovens, lehrs, soaking pits, boilers, etc., this permanently insulated wire is ideal. It won't bake brittle, crack, rot, flow or swell.



ROCKBESTOS THERMOSTAT CONTROL WIRE
Sizes No. 14, 16 and 18 AWG in two to five conductors with .0125", .025" or (for 115 volt service) .031" of impregnated felted asbestos insulation and steel armor.

A multi-conductor wire for fuel burner controls, safety pilots, intercommunications and signal systems. Heatproof, fireproof insulation and steel armor give trouble-proof circuits.

ROCKBESTOS A.V.C. 600 VOLT MOTOR LEAD CABLE
(National Electrical Code, Type AVA)
Size No. 18 AWG to 1,000,000 CM insulated with two walls of impregnated asbestos and a high-dielectric varnished cambric insert, with a heavy asbestos braid overall.

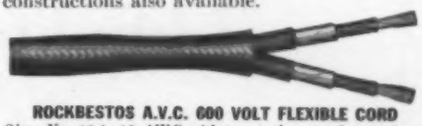
Use this apparatus cable for coil connections, motor and transformer leads exposed to overloads or high ambient temperatures. It makes a permanent installation as it is resistant to heat, flame, oil, grease and moisture.

ROCKBESTOS ASBESTOS INSULATED MAGNET WIRE
Round, square and rectangular asbestos insulated conductors finished to meet varying winding conditions and coil treatment requirements.

Protect motors against heat-induced breakdowns with Class B windings of heat resisting magnet wire. Rockbestos A.V.C. Motor Lead Cable completes the failure-proofing.

ROCKBESTOS 300 VOLT HEAT RESISTING DUPLEX FLEXIBLE CORD
(Underwriters' Type AFPD)
Sizes No. 10 to 18 AWG stranded plain copper conductors insulated with impregnated felted asbestos, polarized, twisted together and covered with a cotton braid.

This heat-resisting cord is approved for use in lighting fixtures and is recommended for pendant types as it does not dry out or crack at the socket. Also on apparatus and appliances which develop heat in operation or are used in hot, dry places. Twisted pair, tripled or triplex constructions also available.



ROCKBESTOS A.V.C. 600 VOLT FLEXIBLE CORD
Sizes No. 10 to 18 AWG with two or three conductors insulated with impregnated felted asbestos, varnished cambric, felted asbestos, covered with heavy impregnated asbestos braid.

A heavy duty, high-dielectric, heat and moisture resistant flexible cord used in locomotive cab circuits, high wattage lighting units, floodlights and for leads on apparatus exposed to heat. Specify polarized conductors if desired. For high temperature applications where resistance to moisture is not required specify All-Asbestos insulated constructions.

ROCKBESTOS ALL-ASBESTOS 600 VOLT RHEOSTAT CABLE
(National Electrical Code, Type AIA)
Sizes No. 18 AWG to 1,000,000 CM insulated with a heavy wall of felted asbestos, covered with a rugged asbestos braid finished in black, white or colors.

Use this cable for wiring rheostats, switchboards, elevator and locomotive control panels and equipment exposed to heat, fumes or fire hazard — also for open power circuits in hot, dry locations. For flexible conductor specify Rockbestos All-Asbestos Flexible Apparatus Cable — for solid conductor, Rockbestos All-Asbestos Rheostat Wire.

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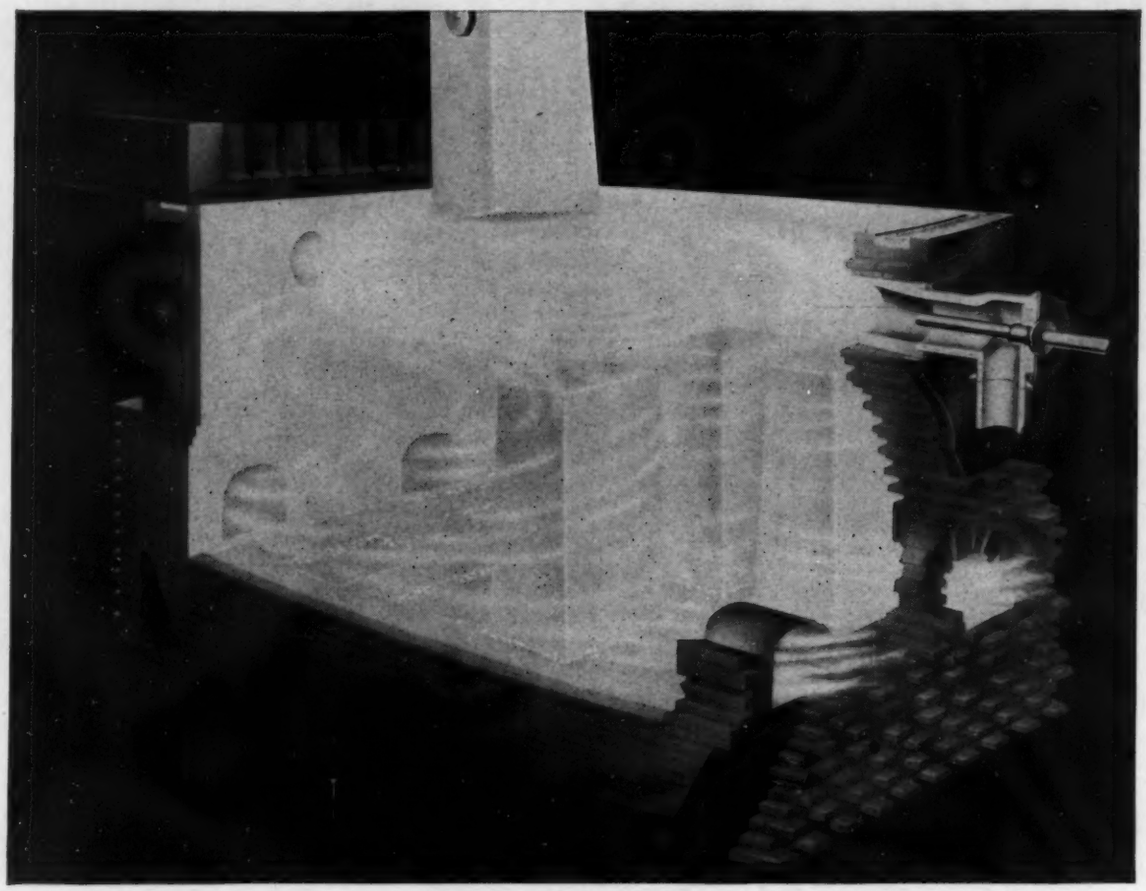
601 NICOLL STREET, NEW HAVEN 4, CONN.

ROCKBESTOS

The Wire with Permanent Insulation



LOFTUS MULTIPLE TOP FIRED SOAKING PITS

OUTSTANDING FEATURES

1. Maximum ingot charge per square foot of Pit area.

2. Minimum building area required.

3. No flame impingement on ingots.

4. Burner and flue arrangement insures uniform temperature throughout the Pit.

5. Recuperator Design provides continuous supply of combustion air at uniform and high preheat.

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7. Automatic control of temperature and atmosphere.

8. Tight cover design.

9. Efficient cover manipulation.

10. Design provides cool cinder aisles, with clear access for ready removal of cinders.

11. Low maintenance.

12. QUALITY HEATING.

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Your Inquiry Will Receive Prompt Attention

From One Furnace to a Complete Plant

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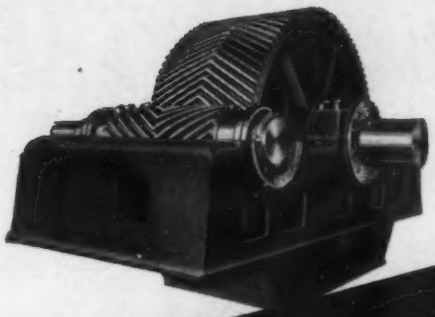
Designers and Builders Engineers, Consultants, Contractors

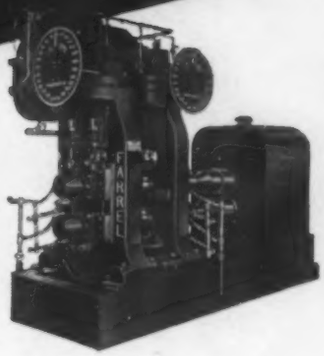


REDUCTION GEAR DRIVES—Designs include single, double and multiple reduction units, in a wide range of ratios and capacities. Continuous tooth herringbone gears — *The Gear with a Backbone* — precision generated by Farrel-Sykes process, provide extra load-carrying capacity and smooth, quiet operation.

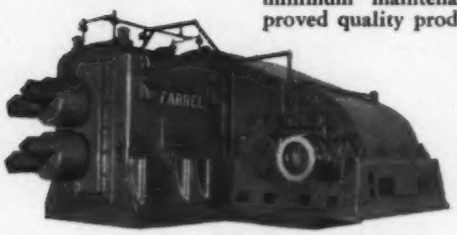
FARREL MILL EQUIPMENT

Engineered for Long Service

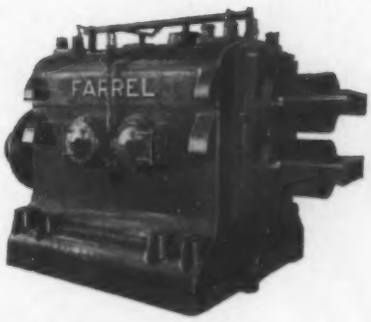
Farrel design gives you rolling mill equipment with operating stamina. At every vital point in each unit you find engineered protection which minimizes wear and preserves dependable performance. A few typical units are illustrated on this page. Information about them or similar units designed to fit your special requirements will be sent on request, without obligation.



ROLLING MILLS — Built in a wide range of sizes for non-ferrous rods, strips or sheets, metal foils and cold strip steel. Complete rod mills from furnace to coilers. Advanced design features contribute to efficient operation, high output, minimum maintenance and improved quality products.



COMBINATION DRIVE UNITS — Include reduction gear drive and pinion stand in compact, integral unit. Designed to withstand the shocks, stresses and wear encountered in continuous, heavy duty service.



PINION STANDS—Double or single helical pinions mounted in sleeve or roller bearings, carried in heavy cast cases, and provided with automatic lubrication. Designed for the job and built in any size and capacity.

ROLL GRINDERS—Built in two types—HD with traveling wheel, and TT with traveling work table—to take maximum diameters from 24" to 60", any length required between centers. Both types grind straight, concave and convex rolls, also shafts and other cylindrical work. Design features insure high quality work, precision and maximum output.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.

Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Chicago, Los Angeles, Tulsa, Houston

FARREL

FARREL ROLLING MACHINERY

- Rolls
- Rolling Mills
- Rod Mill Tables and Manipulating Equipment
- Universal Mill Spindles
- Rod Coilers
- Gears
- Mill Pinions
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Cleaning time	**75 minutes**
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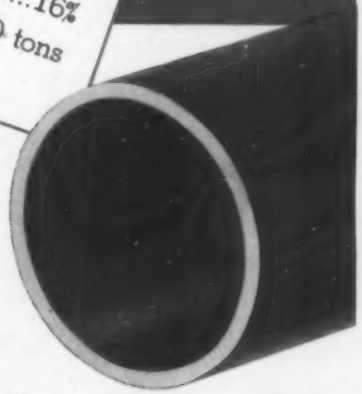
Quantity water required	450 gals./min.
Quantity water after cleaning at 40#	580 gals./min.
Quantity water after cleaning at 50#	750 gals./min. (estimated)
Present pumping time at 40# pressure	7 hrs. less than before cleaning
Power savings	16%
Deposit removed (estimated)	60 tons



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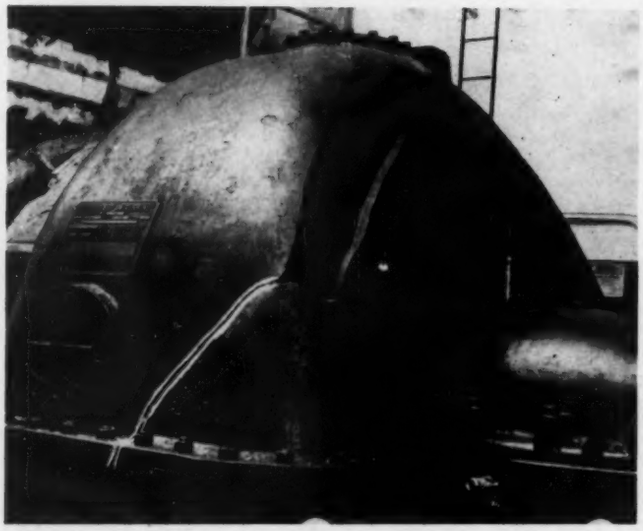

BEFORE Both halves of above 10,000 KW Turbine casing were wrecked by gas explosion while cleaning condenser with acid. Considered total loss before Metalock engineers were consulted.

AFTER Repair made on location in about three weeks passed underwriter inspection. New equipment guarantee given. Estimated savings based on new patterns, new castings and expected production loss set at several hundred thousand dollars.

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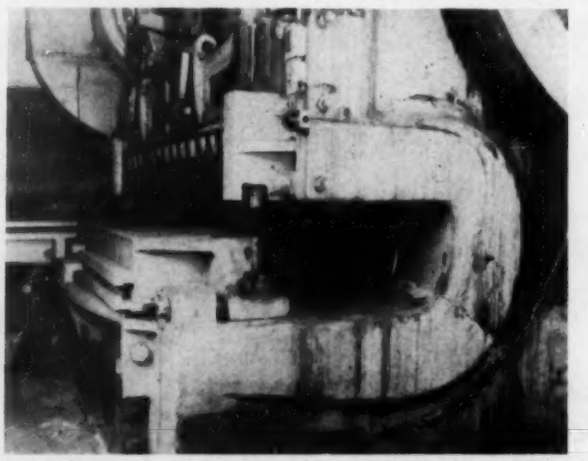
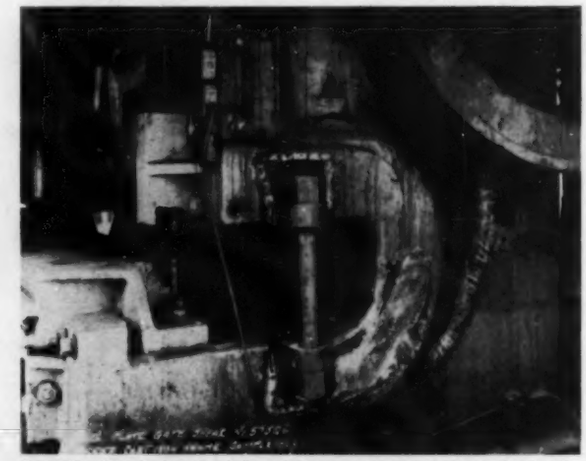


BEFORE Plate shear frame designed for one inch plate failed at both ends due to overload. Serious curtailment of production schedules resulted.



AFTER Repaired and reinforced to carry the required overload. Removable overload strut detachable for increasing throat dimensions when handling lighter materials.

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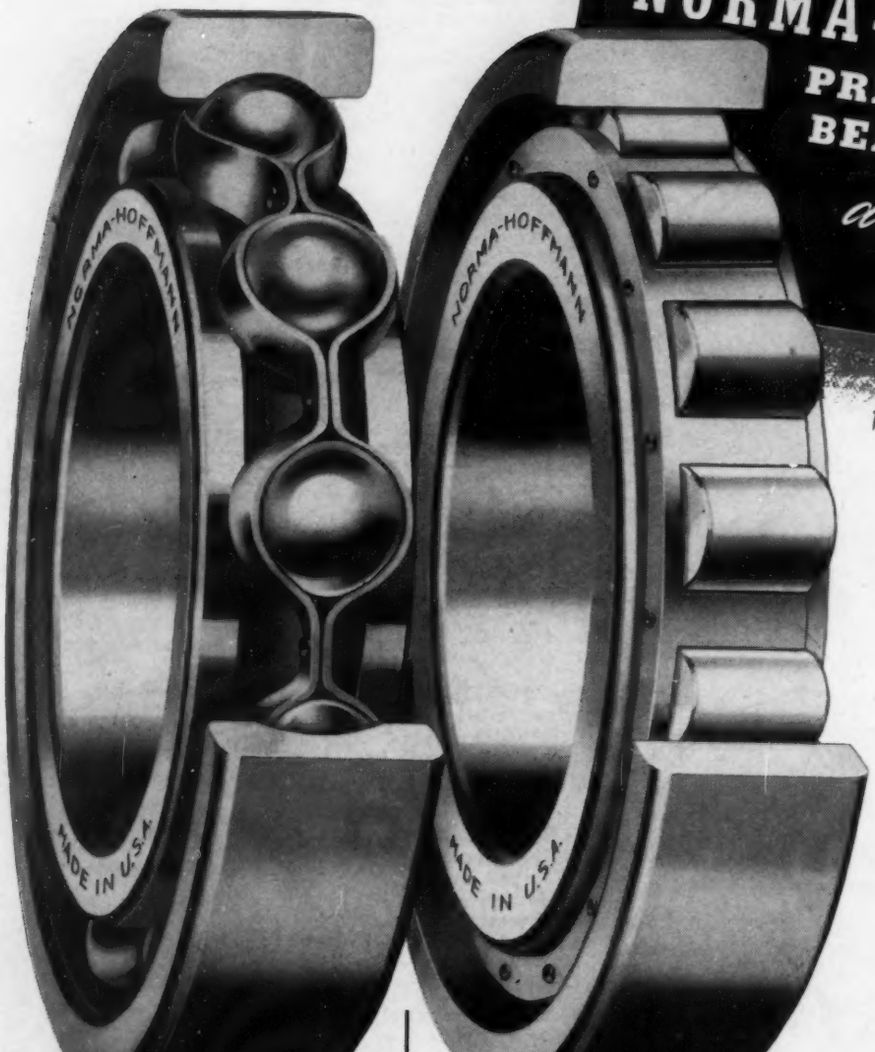

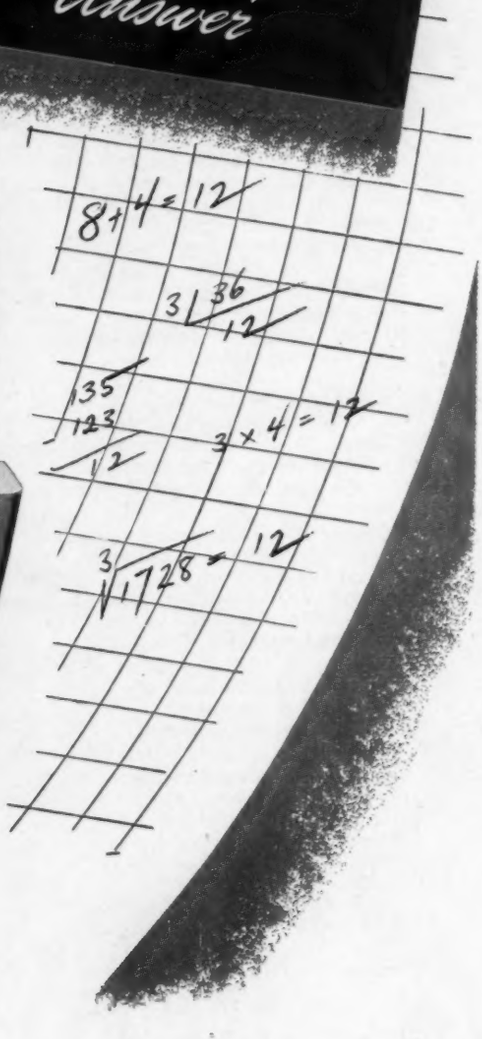

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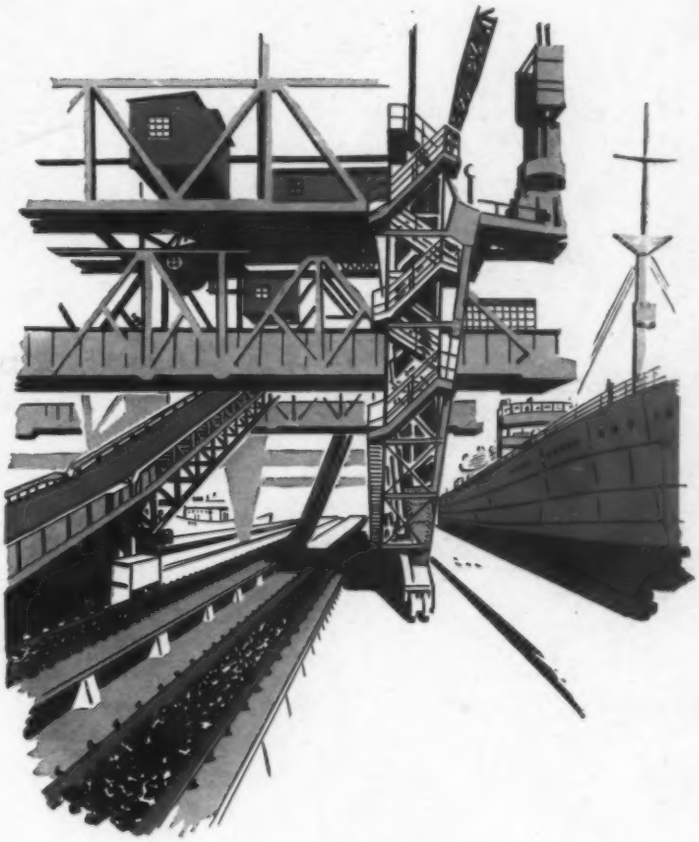

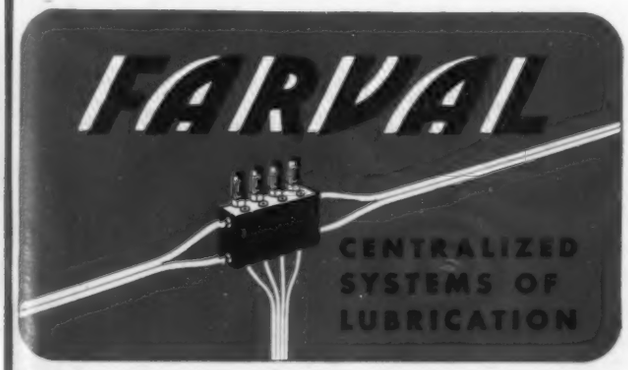

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LIMITAMP CONTROL

GIVES SURE, SHORT-CIRCUIT PROTECTION

In less than *one-quarter* cycle, EJ-2 fuses in Limitamp control can cut off a rise in current from a short, and clear it in one-half cycle—long before the short has time to harm the contactor or motor. Your plant's power system needs this prompt handling of fault currents, and you will avoid the risk of costly shutdowns that can result from one, mad short circuit.

A STARTER AND PROTECTOR IN ONE CABINET

G-E Limitamp control consists of an airbreak contactor (the motor starter), and EJ-2 fuses (the short-circuit device). They are mounted in separate compartments of one, all-steel cabinet.

Airbreak contactors are specially designed for hard duty. Operating experience has proved they furnish reliable, low-cost service with only routine maintenance.

Because they operate in air, they eliminate the problem of handling oil. And tip life of airbreak contactors is many times that of comparable oil-immersed tips.

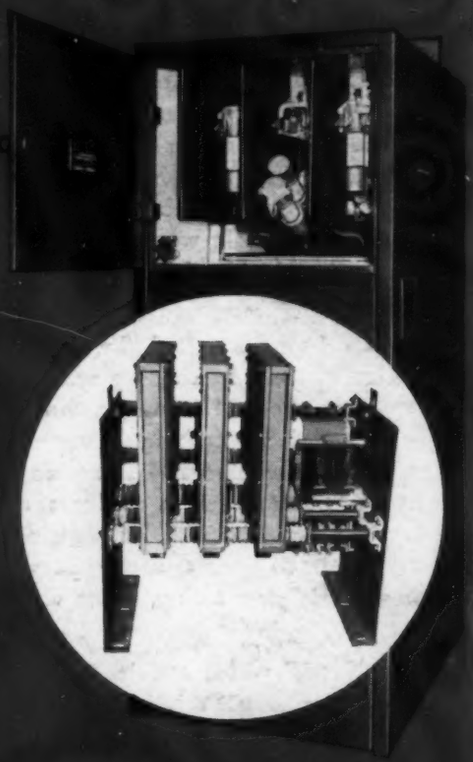
You can depend on EJ-2 fuses for sure, short-circuit protection. They are "fail-safe" devices. There is nothing about them to wear. They are easy to replace.

OVERLOAD AND UNDERVOLTAGE PROTECTION

Isothermic overload relays, accurately calibrated against actual motor characteristics, guard the motor against overheating from sustained loads or single phasing.

FACTORY-ASSEMBLED CONTROL

Factory-assembled in one cabinet, Limitamp is easy to install, easy to co-ordinate with other control, saves space, and improves the appearance of your plant.



Limitamp control is furnished as a single unit, in groups, or in special enclosures for special operating conditions.

The Trend is to AIR

G-E LIMITAMP . . . THE FIRST HIGH-VOLTAGE CONTROLLER WITH AIRBREAK CONTACTORS

GENERAL ELECTRIC

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General Electric Company, Section B676-250
Schenectady 5, New York

Please send me Bulletin GEA-4247 on Limitamp control.

Name.....

Company.....

Address.....